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SOME CURIOUS EXOTIC INSECTS.

In going from the pole to the equator we find that insect life increases in the same proportion as vegetable life. On

Fig. 1.—SCHIZODACTYLUS MONSTRUOSUS.

Melville Island there is not a single beetle; eleven species are found in Greenland; 2,500 in England; and 8,000 in Brazil. Tropical countries, therefore, are the Paradise of the entomologist, not only because of the greater abundance

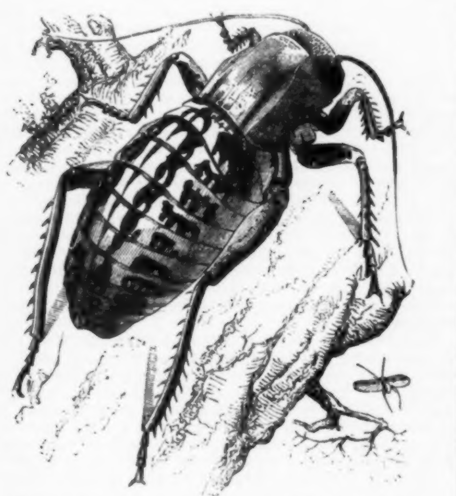


Fig. 2.—BRADYPORA CLOPORTA (MALE).

there of insects, but also because in such regions these are most gorgeously arrayed, most curiously formed, and exhibit the most singular habits and modes of development. In the accompanying engravings, taken from a

Fig. 3.—MYGNIMIA AVICULA.

recent French work on exotic insects, are to be seen some of the interesting forms assumed by these creatures in hot countries.

Fig. 1 is the "Monstrous Cricket" (*Schizodactylus monstruosus*, Drury), one of the largest species of the Orthopterous family *Gryllidæ*, and which has long been known to collectors. Its body is about two inches long, and is of a yellowish color spotted with brown. This species, with its long, slender antennæ, exhibits characters that are found in no other insect; the pseudelytra and wings, which are much larger than the body, are twisted, in repose, into several close spirals at their extremity, and the joints of the tarsi are provided with singular dilatations that make them resemble the webbed feet of certain aquatic birds, like the grebes. This Schizodactyl, the name of which is derived from the last-mentioned peculiarity, inhabits eastern India. On the banks of the Ganges it digs a hole about three feet deep, and remains concealed therein during the daytime, and flies about only during the night. The family of *Acrydii*, or true grasshoppers, is allied to the foregoing, and embraces insects of gigantic proportions. The migratory locust (*Acrydium migratorium*) is a most destructive insect from its voracity and vast numbers. The *Caloptenus spretus*

Fig. 4.—ATTA BARBARICA (WORKER).

appears in immense numbers in the country between the Mississippi and the Rocky Mountains, where they commit great havoc. A gigantic species, *Tropidacris rex*, of South America, expands some eight inches, and has gayly colored hind wings. Some of the species of this family are wingless; among these may be noted the tropical species, *Bradypora cloporta* (Fig. 2), a large and robust grasshopper, the female of which is entirely deprived of wings, while the male has only rudiments of elytra. Both sexes are of a pretty shade of green, spotted with black.

The order *Hymenoptera* includes the bees, wasps, sawflies, ants, etc. The transformations of this order are the most complete of all insects, and many of the species embraced therein are endowed with instincts, and a kind of reasoning differing, perhaps, only in degree from that of man. The family *Pompilidæ* of this order includes about 700 species, having a wide geographical range, from the temperate zone to the tropics. They oviposit in the body of other insects, storing their nests, usually built in the sand, with spiders and caterpillars. Their sting is very large and

Fig. 5.—ŒCODOMA CEPHALOTES (WORKER).

formidable, and excessively painful, benumbing the part it enters. In the genus *Pompilus* there are about five hundred species; one of these, the *P. formosus*, called in Texas the tarantula-killer, attacks that immense spider, the *Mygale*, and paralyzes it with its formidable sting, and inserting an egg in its body, places it in its nest, dug to the depth of five inches. Much more formidable still are the stings of the large *Pompilidæ* of tropical regions, especially those of the *Pepsis*. There are about fifty species of these, in which the body is of a brilliant black or blue, or metallic green. The rich colors of their wings are due to scales almost like those of butterflies. We figure herewith a large species from Java, the *Mygnimia avicula* (Fig. 3), which is wholly of a dull black color sprinkled with white dots, giving it an appearance as if covered with hoar frost; its wings are also black, with a satiny white spot at their tips.

A very curious aberrant group of the *Hymenoptera* is that of the *Formicariæ*, or family of ants, insects of social habits, and the reproduction of which requires the concurrence of three or four distinct forms. At certain seasons of the year these insects swarm. The females, after their marriage flight in the air, enter the ground to lay their eggs, and, having no more use for their wings, pluck them off. The great majority of the insects in a *formicarium* are wingless

Fig. 6.—PACHYLIS GIGANTEA.

workers, which are the architects of the nest, and which feed the larvæ with food elaborated in their stomachs. Sometimes, and especially among exotic ants, there is another form of neuters, fewer than the workers and, like the latter, wingless. These are the soldiers of the community—the defenders of the *formicarium*. They are easily recog-

Fig. 7.—CATOCANTHA INCARNATA.

nized by their immense heads, armed with powerful mandibles. There are three principal groups of the *Formicariæ*—the ants, properly so called, which are stingless, and the *Poneraria*, and the *Myrmicariæ*, provided with stings. In the latter group we find the greatest variety as regards form and habits. The larvæ of stingless genera usually spin a delicate silken cocoon, while those of the aculeate genera

Fig. 8.—BELL-BEARING BOCYDIA (ENLARGED).

do not. A marked type of the *Myrmicariæ* is the genus *Atta*, distinguished by having workers with enormous, heart-shaped heads. These ants are very injurious to agriculture, inasmuch as they are vegetable feeders, and store up immense quantities of the seeds of grass, grain, and leguminous plants. These ants are known throughout the Orient and the center

of Europe. It was these insects that Solomon had in view when he speaks in Proverbs of the foresight of the ant, in laying up provisions for the winter. The *Atta barbarica* (Fig. 4) abounds in Algeria as far as the confines of the Sahara, and is also found in the extreme south of France. One species of the genus is found in Mexico. In tropical America there are other *Myrmicida* which are almost exclusively leaf eaters. One of the most important of these in Brazil and Guiana is the *Œcodoma cephalotes* (Fig. 5), or the dreaded "Saübas." Well-beaten paths branch off in every direction through the forests, on which broad columns of these insects may be seen marching to and fro, each bearing vertically a circular piece of leaf. Unfortunately they prefer cultivated trees, especially the coffee and orange. They are also given to plundering provisions; in a single night they will carry off bushels of farina. Bates says that they have regular divisions of laborers, numbers mounting the trees and cutting off the leaves in regularly rounded pieces the size of a shilling, and another relay carrying them off as they fall. These ants are of a light red color, with powerful jaws. In every formicarium there are three sets of individuals—males, females, and workers; but the Saübas have the singularity of possessing three classes of workers. These insects are eaten by the Rio Negro Indians and esteemed a luxury; while the Tapajos tribes use them for seasoning their mandioca sauce.

The order *Hemiptera* includes the true "bugs," plant lice, bedbugs, body lice, etc., and may be briefly characterized by the beak-like sucking mouth parts, by the free large prothorax, the usually angular short body, and the irregularly veined wings, the veins being few in number, while the fore wings are often coriaceous and opaque.

The family *Corisiæ* is a very extensive one, and especially rich in species in the tropics, where they are gayly colored. The genus *Pachylis* (Fig. 6) includes species peculiar to South America, and which have short flat heads, three jointed tarsi, and claws provided with suctorial pads. This genus is allied to the one containing the chinch bug—a great enemy of our wheat crops. Another beautiful exotic species of this family is the *Catacantha incarnata* (Fig. 7) of India, which varies from yellow to red, with black dots, and having dark blue hind wings.

The *Homopterous Hemiptera* include such genera as have the fore pair of wings transparent and net-veined, lying with the hind pair, which are smaller, roof-like upon the body; and the head held vertically, where in most Heteroptera it is horizontal and flattened. In this division there is a very strange family composed of small insects which are chiefly natives of Brazil, Guiana, and Florida. Any one looking at a correct delineation of one of these insects would suppose that the artist had endeavored to draw an impossible animal. There is a representative of the type found in France, the *Centrota cornuta*, which Geoffroy, the old historian of Parisian insects, calls the "little horned devil." It is of a brownish-black color, and carries upon the posterior part of its thorax two sharp triangular horns, while the fore part of the thorax is prolonged into a sharp point. The configuration of the genus *Bocydia* is still stranger; one of the Brazilian species, the "bell-bearing Bocydia," about the size of a common fly, and brown, carries, on the thoracic segment of its body (which is black) a rounded tube supporting four nearly globular organs covered with large hairs and a long spine directed backward (Fig. 8).

PREHISTORIC MAN IN GERMANY.

Respecting the discoveries which have just been made in certain caves in Moravia, some interesting details are published in the Augsburg *Allgemeine Zeitung*. For some months past excavations have been going on upon the Kotoutsch hill, near Stramberg, which have already brought to light a large number of remains of the highest scientific interest. The work has been carried on under the direction of Herr J. Maschka, a master at the Realschule of Neutitschein, who has conducted the operations in the most systematic and careful manner. The spots where the most important discoveries have been made are the two caves of Schipka and Tchertova Dira (or the Dwarf's Cave). The objects which have been found, and the position in which they were discovered, prove in the clearest possible manner that both the caves mentioned were inhabited by man in prehistoric ages.

The cave of Schipka, the roof of which has partly fallen in, was, it is shown, occupied by human beings in the oldest stone age, or palæolithic period, while the occupants of the Dwarf's Cave lived at a later era, when man was already, to some extent, acquainted with the use of metals. It is further evident that the caves were occupied by man at a period contemporary with the existence of the mammoth and cave bear, as at a depth of one meter, among the remains of these animals, there were found bones which had been burnt, and others which had been artificially fashioned. The objects obtained in the Schipka Cave comprise thousands of bones of antediluvian animals, as the mammoth, rhinoceros, cave bear, horse, cave ox, stag, reindeer, etc. Further, there are thousands of separate teeth and horns of these animals, besides numerous well preserved stone and bone tools, which were dug up as far down as three meters below the floor of the cave.

In the uppermost layer of the cave floor the excavators also found seven objects in bronze, consisting of a celt, five concentric rings, and one ring with a rectangular cross or wheel with four spokes. In the Tchertova Dira the discoveries include bones of the cave bear, reindeer, edelhirsch, primeval ox, etc., besides numerous pieces of horn showing artificial work, and many well preserved bone objects and tools, such as awls or bodkins, and pins or needles pierced with holes, three and four edged arrow heads, rough and unpolished stone tools of flint, jasper, and chalcedony; fragments of very different kinds of earthenware vessels, with and without graphite coating, which had been made by hand, without the use of the potter's wheel, and which are covered with characteristic ornaments. Further, there are some three edged arrow points of bronze, with a hole for poison; there are teeth pierced with a hole, mussel shells, whetstones, and bobbins for spinning.

On the crown of the hill above this cave extensive patches of ground on which there had been fires have been found, and immediately under the turf, along with numberless fragments of pottery, there were dug up fragments of graphite vessels, stone tools, and, among other things, a knife 117 millimeters in length, a polished ball with a hole through it, and various bronze and iron objects.

As in Austria cave remains of this kind, with the exception of those of the Vypusthek Cave, have never been discovered, and as in all Central Europe they have but seldom been found, it is readily understood that these excavations are exciting the keenest interest among anthropologists, and it is to be hoped that the researches may be fully and thoroughly carried out, as it is to be anticipated that there are still many more objects of interest yet to brought out of their hiding places, where they have lain for thousands of years, in order to help to clear up the mystery of man's first appearance on earth.

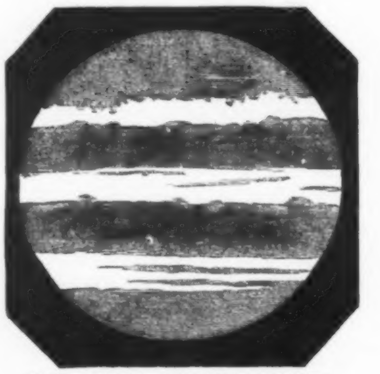
By the result of the excavations we have above described the series of discoveries in reference to the original human inhabitants of Central Europe has been considerably extended. The nearest spots in middle Europe where discoveries have been made similar to these in Moravia, are in the southwest of Germany, thus leaving a wide interval in which nothing of the kind has up to the present time been found.

THE GIANT OF THE WORLDS.*

By Camille Flammarion.

Of all the floating islands which compose the celestial archipelago to which the earth belongs, the planet consecrated from remotest ages to Jupiter the Mighty, king of the gods and men, is the vastest, the most important, and the most majestic. This colossal world of Jupiter has a diameter of about 89,000 miles, and which surpasses that of our earth by more than eleven times. The circumference of Jupiter's world at the equator is about 275,000,000 miles. The volume of this giant exceeds that of the earth by twelve hundred and thirty-four times. This immense globe, seen at the distance at which we are situated from the moon, would appear to us with a diameter about forty times larger than that of our satellite, and the surface of its disk would embrace on the celestial vault an extent sixteen hundred times greater than that of the full moon!

This giant of the world travels through space, accompanied by a retinue of four satellites, at a mean distance of 496,000,000 miles from the sun, and which is more than five times greater than that of the earth from the same. Its orbit is more than a thousand million miles in extent, and through this it passes in 4,332 days, or 11 years 10 months and 17 days. Such is the year of this immense globe! In order to complete its entire orbit during this period, it speeds around the sun with a velocity of about 700,000 miles a day, or a little more than 8 miles a second. This is a little less than half the velocity of the earth in its orbit. But it revolves on its axis with very great swiftness, for its day and night combined only last nine hours and fifty-five minutes; in other words, the inhabitants of Jupiter enjoy only five hours of real day, twilight included. "If," says Kant, "an inhabitant of Jupiter should die in childhood, having lived but one year on that planet, he would be as old as a child who should die on our globe at the age of eleven years and three hundred and fourteen days. The terrestrial child would have lived about one hundred and three thousand nine hundred and sixty-eight of Jupiter's days, and the child on Jupiter, four thousand three hundred and twenty-nine of the earth's days."



THE GIANT OF THE WORLDS.

The extreme velocity of Jupiter's rotatory motion has caused a considerable flattening at the poles, the length of one of this planet's meridians being to that of its equator as one hundred and sixty-seven is to one hundred and seventy-seven, or, in other words, seventeen times shorter. This flattening, which had been already noticed by Cassini, had a very great influence on the ideas of Newton touching the figure of the terrestrial globe.

It does not follow, because Jupiter is a globe 1,234 times larger than the earth, that its mass is in the same proportion; and the fact is that the density of this planet is about four times less than that of our own. It has hence been concluded that Jupiter is composed of light substances like those that we find here on the surface of our soil.

The sun, which is five times more distant from this world than it is from our own, exhibits a very tame appearance to the inhabitants of Jupiter as compared with its aspect to us. They see it rise at their horizon like a fifth moon, possessing a very singular motion, and giving their planet a brighter light and an intenser heat than the others do. This light and heat is twenty-seven times less than that received by the earth from its luminary. This datum furnished Christiern Wolff, a German philosopher of the last century, a pretended method of determining within about an inch the stature of the men who inhabit Jupiter. This is too curious, and especially too singular, to be passed by in silence. We will allow the philosopher to speak for himself:

Says he: "We are taught in optics that the pupil of the eye is dilated by a feeble light and contracted by an intense one. The light of the sun being much less intense for the inhabitants of Jupiter than for us, owing to their far greater distance from this star, it follows that these men have pupils that are larger and much more dilated than ours. Now, we observe that the pupil is in constant proportion to the globe of the eye, and the eye to the rest of the body; so that the more an animal's pupil is developed, the larger the eye, and the larger also the body."

From this principle (the soundness of which we shall examine) Wolff deduces the following conclusions:

"In order to determine the size of the inhabitants of Jupiter, we must consider that the distance from Jupiter to the sun is to the distance from the earth to the sun as twenty-six is to five, and, consequently, that the sun's light with respect to Jupiter is to this light with respect to the earth in the double ratio of five to twenty-six. On another hand, experience teaches us that the dilatation of the pupil is always more than proportional to the increase of the light's intensity; otherwise a body placed at a great distance would appear as clearly defined as another placed nearer. The diameter of the pupil of Jupiter's inhabitants, then, is to the diameter of our own in a greater proportion than five to twenty-six. Let us suppose it ten to twenty-six, or five to thirteen. The usual height of the earth's inhabitants being about five feet four inches, we conclude that the ordinary height of Jupiter's inhabitants must be fourteen and two-thirds feet. Now this was about the size of Og, King of Bashan, whose bed, according to Moses, was nine cubits long by four wide."

We do not know in what treatise on optics Wolff has seen the fact stated that the pupil of the eye is always proportional to its globe, and the latter to the rest of the body, but the simplest observations give the lie to this datum, upon which rests the whole superstructure of the fourteen and two-thirds foot men reputed to live on Jupiter. Thus, no one has seen a whale without being struck with the disproportion existing between the small size of its eye and the gigantic size of its body. The elephant, so wonderful on account of its enormous stature, in the same way attracts our notice because of the smallness of its eye, while the same organ of the fly is remarkable for its extremely large size. Has not the tiger, which is inferior to the hog as regards the size of its body, a much more largely developed eye than the latter? Let any one examine the pupil of man and that of the owl, and he will see that in this respect the king of nature is much less favored than the lugubrious bird of darkness. Finally, there are certain insects known whose eyes are infinitely larger than those of the mole, etc. These few remarks will suffice to show that the theory of Wolff is of no account.

Huygens is not so dogmatic, and, for that very reason, is much more reasonable in his conjectures as to the stature of Jupiter's inhabitants: "If the proportions of organized bodies," says he, "are in ratio to the size of these globes, there would be in Jupiter and Saturn animals ten or fifteen times higher than elephants and longer than whales. Beings endowed with reason would be there of a stature more than gigantic. All this might indeed be possible, but we have no means of proving it. Nature is in no way bound to follow measurements and proportions, which, in our estimation, might seem just and reasonable. Thus, the size of the planetary globes has not been regulated according to their distance from the sun, for Mars is evidently smaller than Venus, although much more distant from the solar orb." Certain conditions might even lead us to think that Jupiter's inhabitants are not larger, but smaller, than we; for we are taught by what we know of the force of gravity at the surface of that planet that a man of our stature transported to Jupiter would weigh there two and a half times more than he did here, and would be greatly oppressed by his own weight. Life would be an insupportable burden to him.

If we wish to find out what difference of stature would correspond (all things being equal) to our muscular activity, we will remark that the weight of bodies increases as the cube of the height, or, in other words, a body twice the height of another one weighs eight times as much. But the muscular strength of living beings does not increase in the same proportion, for it varies as the square of the section of the muscles; or, to state it in another way, of two animals similarly constituted, but one twice as large as the other, the larger of the two will be four times the stronger; but, as it would weigh eight times more, it would consequently be half less active. In a like manner, a being three times as large as another of the same conformation would possess only a third of its activity. Now, since a terrestrial man transported to Jupiter would be two and a half times heavier than he would here, it plainly follows that a Jovian proportioned like a terrestrial would only possess an equal amount of activity with ourselves, provided he weighed two and a half times less than we. In admitting, then, six feet as the maximum stature of terrestrial men, we see that the best-developed men of Jupiter—its grenadiers and its giants—would be only two and a half feet tall; and that General Tom Thumb would there cut an entirely different figure from that that he does here, since he would be able to "pose," on the contrary, like a drum-major at the head of a lilliputian regiment.

The absurdity of these different conclusions is enough to convince us that our premises are erroneous, and that we must take care not to measure the inhabitants of other worlds according to the more or less incomplete conceptions that the forms of terrestrial life may suggest to us. It is, on the contrary, very natural for us to assume that nature has peopled other worlds with creatures as different one from another as the insect is from the quadruped, and still more so, since here essential differences of composition are concerned. Let us not assume for all that, with certain authors, that the inhabitants of Jupiter are gelatinous creatures, floating like medusæ in the lower strata of its thick atmosphere; for all the forms that it would be possible for us to imagine would be at once grotesque and insignificant.

But one of the best of reasons that we have for not trying to guess how the inhabitants of this vast world are made is that it is very probable that they do not as yet exist, and that this celestial globe is not yet actually inhabited by human beings. Its meteorological condition, as we observe it from here, shows us that this planet's atmosphere undergoes greater variations than those which would be produced by the action of the sun alone. This world, in fact, receives twenty-seven times less heat from the sun than we do, and yet it appears to be at least as warm as the earth, and as varied in its meteorology; and its surface does not even seem to have reached that state of fixidity and stability that the earth has at the present day.

Since the invention of telescopes has permitted us to distinguish the shape of Jupiter clearly, we see upon its disk grayish markings in the form of nearly parallel bands. Their number, their positions, and their dimensions do not always remain the same; sometimes as many as eight have been observed, while at other times a single one was permanent. The latter, the largest of all, and nearly always visible, is situated in the northern hemisphere and very near the center of the planet. Another dark belt, situated in the southern hemisphere, and likewise near the center, is likewise nearly permanent.

The principal belts are almost always parallel to Jupiter's equator. The nearly constant parallelism of the belts with respect to the equator and the latitudes of the planet is explained by the rotatory motion, and the angular velocity of this motion, which is considerable. By virtue of this very motion, it will be seen that if there are fluid, liquid, or gaseous matters on the surface of Jupiter, the velocity with which they are carried onward will tend to arrange them in long belts such as we observe; and, as the absolute velocity is greatest at the equator, these masses must accumulate in the largest proportion at that region.

The brilliant belts and the polar regions of Jupiter, whose

* Translated from the *Journal des Connaissances Utiles* for the Scientific American.

light exceeds that of the pale or yellowish belts, are the zones in which this planet's atmosphere is most charged with clouds. The pale bands correspond with the regions in which the atmosphere, in a perfectly clear state, allows the solar rays to reach the surface of the planet, where reflection is not so strong as it is upon the clouds.

The explanation of the luminous and dark belts is quite satisfactory, if we regard the brilliant zones as masses of clouds, and the others as transparent parts of the atmosphere. But is it the solid part of Jupiter that we perceive through the latter, and, if so, what are the darker and more or less permanent spots which have served to measure its rotation? The first series of observations was begun by Cassini in the month of July, 1665. The spot observed by this astronomer was black and appeared to be adherent to the southern belt; and it gave him 9 hours and 56 minutes as the time of the planet's rotation. Later on, in 1672, analogous observations of a spot which the same astronomer believed to be identical with the one that he had observed in Italy, gave him 9 hours 55 minutes and 51 seconds as the period of rotation. On resuming this interesting research in 1677 he reached the conclusion that the time of rotation was 9 hours 55 minutes and 50 seconds. But this splendid harmony disappeared in 1690; for, having at that time observed a spot which seemed to be adherent to the southern belt near the center, he found the time to be 9 hours and 51 minutes. This result, so different from the first ones, was confirmed in 1691 by the observation of two brilliant spots situated on the dark belt nearest the center and toward the north, and also by a dark spot situated between the two central bands. In 1692 the spots gave only 9 hours and 50 minutes as the time of rotation.

The important differences of these various results had already led to the supposition that the spots are clouds floating in an extremely troubled atmosphere, and that the nearer their position to the center of the planet the more rapid their motion.

In 1778 Sir William Herschel devoted himself to an attentive observation of the motion of a dark spot that he had remarked upon an equatorial zone, and drew the conclusion therefrom that the period of rotation varied between 9 hours 54 minutes and 53 seconds, and 9 hours 55 minutes and 40 seconds.

In 1779, a clear spot, also equatorial, gave the same observer at one time 9 hours 51 minutes and 45 seconds, and at another 9 hours 50 minutes and 48 seconds. Herschel explained the great differences of all these observations by the peculiar movements of the spots. He also believed that there existed winds analogous to our trade-winds in the equinoctial regions of the planet.

Afterward came the observations of Beer and Mädler in 1834. These astronomers found themselves in the same position as those who had made observations before them; the spots which they followed up were not fixed regions, but, according to all appearances, products of the atmosphere, analogous to clouds. Their proportional size, their intensity, and their stability essentially distinguished them, it is true, from terrestrial clouds; but the year of Jupiter, which is longer than ours, the small variations in the seasons, and the denser atmosphere of that planet, explain these differences perfectly, and the more since its enormous gravity must prove an important obstacle to any atmospheric movement. Nevertheless, although the spots are not fixed, they may serve to indicate approximately the planet's rotatory motion. On combining all the aspects that had been observed, these two astronomers found that the mean value of rotations that had been thus determined was 9 hours 55 minutes and 26½ seconds.

Since the year 1873 especially, I have diligently observed the same planet at its four successive periods of opposition, and every year have made thirty drawings of it. From this I have been led to the conclusion that it is impossible to explain the movements of the spots if we suppose a uniform rotation. From the irregularities of the belts I have calculated the rotation to be 9 hours 54 minutes and 30 seconds at the equator, and 9 hours 55 minutes and 45 seconds toward 35° of latitude; and, moreover, I have discovered a peculiar motion of several white spots, independent of the rotatory motion, sometimes more rapid and sometimes less, and which shows that these are upper clouds that are sometimes driven by a west wind and at others by an east one. The probable time of the globe's rotation, then, is, in round numbers, 9 hours and 55 minutes.

From these comparisons it may be concluded with certainty that the time of rotation of Jupiter's atmosphere is not the same in all latitudes, and that it is more rapid at the equator than on each side of it. This also happens with regard to the sun, whose period of rotation is 24 days 22 hours and 11 minutes at the equator; 25 days 17 hours and 8 minutes at 20° of north latitude, and 27 days 10 hours and 41 minutes at 60° of the same latitude.

This immense planet, then, has a rotatory motion which is twice as swift as that of the earth; and the duration of its day and night, instead of being 24 hours, is not even 10. The time between the rising and setting of the sun is only 4 hours and 57 minutes, and at all times the night is still shorter owing to twilights. Since, on another hand, Jupiter's year is equal to nearly twelve of ours, the shortness of the days gives the inhabitants of that planet 10,455 days in their annual calendar!

The velocity of this motion is such that a point situated at the equator moves at the rate of about 8 miles per second, twenty-six times swifter than a like point at the terrestrial equator. It is this velocity of rotation that has led to the flattening of the planet's poles, and it is this evidently, too, that produces the belts of Jupiter. This planet is the one of our whole system which enjoys the most regular and uniform seasons, for it revolves on an axis almost perpendicular to its orbit. The result is that the sun deviates very little from the planet's equator, and thus nature is maintained in a state of perpetual spring. The temperate zone occupies almost the total surface of the two hemispheres, so that a perpetual equinox reigns therein; that the duration of day and night is the same in all respects for each latitude, and that the temperature of each climate is invariable.

In spite of this, the aspect of the planet varies extraordinarily from one year to another. Sometimes the belts are broad and separated, and sometimes, on the contrary, they are narrow and close together. Occasionally their edges are ragged like those of broken-up clouds, then again they assume the form of a pefectly straight line. Luminous white spots have been seen floating above the atmospheric belts, and sometimes, too, round luminous points analogous to satellites; and dark stripes have also been observed crossing the belts obliquely and lasting for a long time. Finally, the variableness of this world is such that it offers to the observer and thinker one of the most novel and interesting problems of planetary astronomy.

These atmospheric disturbances may nevertheless take place in the immense aerial envelope of Jupiter without the surface of the planet being, for all that, itself in a corresponding state of instability. This surface we rarely or never see through the clear spaces, which, to us, appear dark.

It is probable that this globe, although created before the earth, has preserved its pristine heat much longer by reason of its volume and mass. Is this characteristic heat sufficiently intense to prevent all manifestations of life? And is this globe still at the present time, not in the state of a luminous sun, but in the condition of a dark and burning one, entirely liquid, or scarcely covered with a first hardened crust, as the earth was before life began to appear on its surface? Or, indeed, is this colossal planet in that condition of temperature through which our own world passed during the *primary period of its geological epochs*, when life began to show itself under strange forms, as animal and vegetable beings of astonishing vitality, amid the convulsions and tempests of the new-born world? The last is the most rational conclusion that we can draw from the most recent and exact observations to which we are indebted for what we know of the present state of this vast world.

Whether Jupiter be inhabited now, whether it was yesterday, or whether it will be to-morrow, is of little consequence to the grand, eternal philosophy of nature. Life is the object of its formation, as it was that of the earth's formation. Therein is everything; the moment, the hour, is of no account.

Doubtless this planet may now be inhabited by beings different from us; living, perhaps, in an aerial condition in the upper regions of its atmosphere, above the fogs and vapors of the lower strata; feeding on the aerial fluid itself; resting on the wind like the eagle in the tempest; and ever dwelling in the upper heights of the Jovian heaven. That would not be a disagreeable abode, although an anti-terrestrial one; indeed, it would be like the abode of old Jupiter Olympius and his court.

But if we do not wish, in our conception of life, to stray too far from the borders of the terrestrial cradle, there is nothing to prevent us from waiting until the planet has become cool, like our own, and enjoys a purified atmosphere, which will permit of its being compared with the earth. And what world would be better prepared to be the abode of a superior life? It is the preponderant globe of the whole solar family, the vastest in surface, the most important as regards mass, the most favored through the position of its axis, the most uniform in its course, rich in the possession of four satellites, and throned like a chief amid the planetary orbits. What marvelous conditions are prepared in this abode for the development of life, intelligence, and happiness! Ah, how much superior will such a humanity be to ours!

Happy shores of Jupiter! You will not know those distresses and sorrows at which the unhappy countries of our earth are still shuddering! You will not be moistened with the blood of martyrs, which has been so many times shed here in the name of so many contradictory gods! You will not bear tumultuous armies of brothers, who periodically slaughter each other at the order of a few infamous potentates! You will not be defiled by the crimes that hunger, ambition, or pride is committing every day here below! But you will prepare in the heavens the United States of an immense republic, blessed of the Creator, floating calmly in the luminous ether, bathed in the tepid temperature of an eternal spring, without winter and without summer, and slowly growing, in the breast of peace and harmony, toward a state of perfection which our imperfect and miserable little planet will never approach!

It is impossible for us to imagine that the existence of the stars can have any other object than that of receiving or of giving life. *Life!* Such is the grand object which we see shining in the destinies of the creation. The absence of life is to us a synonym for death and nothingness. Our logic refuses to believe that the millions of suns which are burning in infinite space are of no use, and that they neither illumine, warm, nor govern anything. And, if they *are* useful for something, for us this "something" is life, under whatever form it be, from the simplest blade of grass up to the highest, most intelligent, most powerful mind.

This declaration, which is forced upon us by our own logic, is also the declaration of entire nature, whose unlimited fecundity has sown life around us on every spot capable of receiving it; whose singular foresight gives things and beings even a double and multiple purpose for existence; who produces several effects through the same cause; and who goes so far as to accumulate life at the expense of living beings themselves.

If the gigantic world of Jupiter is now undergoing those conditions of temperature that marked the primitive epochs of the earth, we cannot consider it as being at present the seat of intellectual life. It is the land of the *Ichthyosaurus*, but not that of man; not the calm and tranquil world which is necessary for the manifestations of a delicate, nervous system and of contemplative thought. It is only later on, in future ages, that Jupiter will be inhabited by an intellectual race; and who knows whether, perhaps, it may not be by ourselves! Its situation, then, will be incomparably superior to that of the earth: an immense empire, a perpetual spring, long years, and a mild, unvarying temperature will form an abode of peace and happiness truly worthy of our ambition and our hopes.

This majestic world travels in space, accompanied by four enormous satellites. In what condition are these four worlds? Are they not themselves, and have they not been for a long time, the seat of organic life, and even of an intellectual one? Does not Jupiter's globe furnish them with a modicum of heat, and is it not to them a scarcely extinct sun? The superior volume and mass of this planet, as it moves on, surrounded by these satellites, is a reproduction of the image of the sun itself, in the midst of his four nearest planets—Mercury, Venus, Mars, and the earth; for the distances and relative volumes of Jupiter's four satellites form a system which is singularly analogous to that of the four first planets of the great solar system.

Each one of the four worlds of the Jovian system has its special years, its days, and doubtless, also, its seasons; and the inhabitants of each of them have the same reasons for believing themselves at the center of the entire universe, as the inhabitants of our little earth, who, during so many ages, have dreamed the same dream. To them Jupiter's globe has the aspect of a gigantic moon, which is capable of effectually compensating for the small quantity of light that they receive from the sun. Regarded from the first of the satellites, this immense globe appears 1,400 times greater in surface than our full moon. What a Colossus! Even from the outermost satellite the apparent surface of Jupiter still exceeds by 75 times that which the moon exhibits to us. What magnificent sights are to be contemplated from these observatories! Colossal Jupiter is the most marvelous object of their heavens; to them he is the sovereign of the universe—the true Jupiter—and they admire him no less than we admire the sun. For, to them, the sun is only a small, brilliant disk, while, viewed from the first satellite, the immense globe of Jupiter exceeds it by 35,000 times. Let us add the magic colorations which decorate this disk with glowing tints, from orange and red to violet and purple; let us add, also, the rapid changes in appearance produced by its rotatory motion, and we shall have an approximate idea of the magnificence of the pictures of nature as seen from these four worlds as they are carried along by the giant star into the far-off depths of immensity!

And now a last question, and one of personal interest: What effect does the earth produce as seen from up yonder? Assuredly a very ordinary effect as regards our vanity. It is very probable that the inhabitants of Jupiter and the planets beyond consider the region of the solar system in which we live as empty. If Jupiter and the earth were to exchange situations the inhabitants of the former would see our globe as a pale star of the sixth magnitude, and scarcely perceptible to the naked eye—just as Uranus appears to us. But, in the position that we occupy with respect to Jupiter, the earth, at the moment of its conjunction, is, like Venus, subjected to phases which render the whole or the greater part of its disk invisible. Almost always lost amid the solar rays, it would appear like a black point, when an observer on Jupiter chanced to see it pass across the disk of the sun, and not, as Fontenelle supposed, with the aspect of a star visible at night. This little black point has not as much importance, in the eyes of the inhabitants of Jupiter, as that which Mr. Bismarck attaches to the momentary possession of one of his minute provinces, and, were it known on this far distant world that certain philosophers of the little black point had assumed that the whole universe was created and put in the world on purpose for them, there is reason to believe that the whole population of the four worlds of Jupiter would be seized with a fit of laughter worthy of being sung by a Homer, and that the uproar produced would be so great that it might well be heard from here.

[Continued from SUPPLEMENT, No. 195.]

BRITISH ASSOCIATION—THE PRESIDENT'S ADDRESS.

REJUVENESCENCE.

RELATED to the formation of new cells, whether by division or by free cell formation, is another very interesting phenomenon of living protoplasm known as "rejuvenescence." In this the whole protoplasm of a cell, by a new arrangement of its parts, assumes a new shape and acquires new properties. It then abandons its cellulose chamber, and enters on a new and independent life in the surrounding medium. A good example of this is afforded by the formation of swarm-spores in Oedogonium, one of the freshwater algæ. Here the whole of the protoplasm of an adult cell contracts, and by the expulsion of its cell sap changes from a cylindrical to a globular shape. Then one spot becomes clear, and a pencil of vibratile cilia here shows itself. The cellulose wall which had hitherto confined it now becomes ruptured, and the protoplasmic sphere, endowed with new faculties of development and with powers of active locomotion, escapes as a swarm-spore, which, after enjoying for a time the free life of an animal, comes to rest, and develops itself into a new plant. The beautiful researches which have within the last few years been made by the observers already mentioned, on the division of animal cells, show how close is the agreement between plants and animals in all the leading phenomena of cell division, and afford one more proof of the essential unity of the two great organic kingdoms.

THE EGG A TYPICAL CELL.

There is one form of cell which, in its relation to the organic world, possesses a significance beyond that of every other, namely, the egg. As already stated, the egg is, wherever it occurs, a typical cell, consisting essentially of a globule of protoplasm enveloping a nucleus (the "germinal vesicle"), and with one or more nucleoli (the "germinal spots") in the interior of the nucleus. This cell, distinguishable by no tangible characters from thousands of other cells, is nevertheless destined to run through a definite series of developmental changes, which have as their end the building up of an organism like that to which the egg owes its origin. It is obvious that such complex organisms as thus result—composed, it may be, of countless millions of cells—can be derived from the simple egg cell only by a process of cell multiplication. The birth of new cells derived from the primary cell or egg thus lies at the basis of embryonic development. It is here that the phenomena of cell multiplication in the animal kingdom can in general be most satisfactorily observed, and the greater number of recent researches into the nature of these phenomena have found their most fertile field in the early periods of the development of the egg. A discussion of the still earlier changes which the egg undergoes in order to bring it into the condition in which multiplication may be possible, would, however full of interest, be here out of place; and I shall therefore confine myself to the first moments of actual development—to what is called "the cleavage of the egg"—which is nothing more than the multiplication of the egg cell by repeated division. I shall further confine myself to an account of this phenomenon as presented in typical cases, leaving out of consideration certain modifications which would only complicate and obscure our picture.

THE CLEAVAGE OF THE EGG.

The egg, notwithstanding the preliminary changes to which I have alluded, is still, at the commencement of development, a true cell. It has its protoplasm and its nucleus, and it is, as a rule, enveloped in a delicate membrane. The protoplasm forms what is known as the vitellus, or yolk, and the surrounding membrane is called the "vitellary membrane." The division which is now about to take place in it is introduced by a change of form in the nucleus. This becomes elongated, and assumes the shape of a spindle, similar to what we have already seen in the cell-division of plants. On each pole of the spindle transparent protoplasm collects, forming here a clear spherical area. At this time a very striking and characteristic phenomenon is witnessed in the egg. Each pole of the spindle has become the center of a system of rays which stream out in all directions into the surrounding protoplasm. The protoplasm thus shows, enveloped in its mass, two sun-like figures, whose centers are connected to one another by the spindle-shaped nucleus. To this, with the sun-like rays streaming from its poles, Auerbach gives the name of "Karyolitic figure," suggested by its connection with the breaking up of the original nucleus, to which our attention must next be directed. A

phenomenon similar to one we have already seen in the cell division among plants now shows itself. The nucleus becomes broken up into a number of filaments, which lie together in a bundle, each filament stretching from pole to pole of the spindle. Exactly in its central point every filament shows a knot-like enlargement, and from the close approximation of the knots there results a thick zone of protoplasm in the equator of the spindle. Each knot soon divides into two halves, and each half recedes from the equator and travels along the filament toward its extremity. When arrived at the poles of the spindle each set of half knots becomes fused together into a globular body, while the intervening portion of the spindle, becoming torn up, and gradually drawn into the substance of the two globular masses, finally disappears And, now, instead of the single fusiform nucleus whose changes we have been tracing, we have two new globular nuclei, each occupying the place of one of its poles, and formed at its expense. The egg now begins to divide along a plane at right angles to a line connecting the two nuclei. The division takes place without the formation of a cell plate such as we saw in the division of the plant cell, and is introduced by a constriction of its protoplasm, which commences at the circumference just within the vitelline membrane, and, extending toward the center, divides the whole mass of protoplasm into two halves, each including within it one of the new nuclei. Thus the simple cell which constituted the condition of the egg at the commencement of development becomes divided into two similar cells. This forms the first stage of cleavage. Each of these two young cells divides in its turn in a direction at right angles to the first division-plane, while by continued repetition of the same act the whole of the protoplasm or yoke becomes broken up into a vast multitude of cells, and the unicellular organism—the egg, with which we began our history—has become converted into an organism composed of many thousands of cells. This is one of the most widely distributed phenomena of the organic world. It is called "the cleavage of the egg," and consists essentially in the production, by division, of the successive broods of cells, from a single ancestral cell, the egg. It is no part of my purpose to carry on the phenomena of development further than this. Such of my hearers as may desire to become acquainted with the further history of the embryo, I would refer to the excellent address delivered two years ago at the Plymouth meeting of the Association by one of my predecessors in this chair—Prof. Allen Thompson.

THE FORMATION OF PLASMODIA.

That protoplasm, however, may present a phenomenon the reverse of that in which a simple cell becomes multiplied into many, is shown by a phenomenon already referred to—the production of plasmodia in the *Myxomyceta* by the fusion into one another of cells originally distinct. The genus *Myriothela* will afford another example in which the formation of plasmodia becomes introduced into the cycle of development. The primitive eggs are here, as elsewhere, true cells with nucleolated nuclei, but without any boundary membrane. They are formed in considerable numbers, but remain only for a short time separate and distinct. After this they begin to exhibit amœboid changes of shape, project pseudopodial prolongations which coalesce with those of others in their vicinity, and finally a multitude of these primitive ova become fused together into a common plasmodium, in which, as in the simple egg cell of other animals, the phenomena of development take place. In many of the lower plants a very similar coalescence is known to take place between the protoplasmic bodies of separate cells, and constitutes the phenomenon of conjugation. Spirogyra is a genus of algæ, consisting of long green threads common in ponds. Every thread is composed of a series of cylindrical chambers of transparent cellulose placed end to end, each containing a sac of protoplasm with a large quantity of cell sap, and with a green band of chlorophyl wound spirally on its walls. When the threads have attained their full growth they approach one another in pairs, and lie in close proximity, parallel one to the other. A communication is then established by means of short connecting tubes between the chambers of adjacent filaments, and across the channel thus formed the whole of the protoplasm of one of the conjugating chambers passes into the cavity of the other, and then immediately fuses with the protoplasm it finds there. The single mass thus formed shapes itself into a solid oval body, known as a "zygospore." This now frees itself from the filament, secretes over its naked surface a new wall of cellulose, and, when placed in the conditions necessary for its development, attaches itself by one end, and then, by repeated acts of cell division, grows into a many-celled filament like those in which it originated. The formation of plasmodia, regarded as a coalescence and absolute fusion into one another of separate naked masses of protoplasm, is a phenomenon of great significance. It is highly probable that, notwithstanding the complete loss of individuality in the combining elements, such difference as may have been present in these will always find itself expressed in the properties of the resulting plasmodia—a fact of great importance in its bearing on the phenomena of inheritance. Recent researches, indeed, render it almost certain that fertilization, whether in the animal or the vegetable kingdom, consists essentially in the coalescence and consequent loss of individuality of the protoplasmic contents of two cells.

CHLOROPHYL.

In by far the greater number of plants the protoplasm of most of the cells which are exposed to the sunlight undergoes a curious and important differentiation, part of it becoming separated from the remainder in the form usually of green granules, known as chlorophyl granules. The chlorophyl granules thus consist of true protoplasm, their color being due to the presence af a green coloring matter, which may be extracted, leaving behind the colorless protoplasmic base. The coloring matter of chlorophyl presents under the spectroscope a very characteristic spectrum. For our knowledge of its optical properties, on which time will not now permit me to dwell, we are mainly indebted to the researches of your townsman, Dr. Sorby, who has made these the subject of a series of elaborate investigations, which have contributed largely to the advancement of an important department of physical science. That the chlorophyl is a living substance, like the uncolored protoplasm of the cell, is sufficiently obvious. When once formed, the chlorophyl granule may grow by intussusception of nutriment to many times its original size, and may multiply itself by division. To the presence of chlorophyl is due one of the most striking aspects of external nature—the green color of the vegetation which clothes the surface of the earth; and with its formation is introduced a function of fundamental importance in the economy of plants, for it is on the cells which contain this substance that devolves the faculty of decomposing carbonic acid. On this depends the assimilation of plants, a process which becomes manifest externally by the exhalation of oxygen. Now it is under the influence of light on the chlorophyl-containing cells that this evolution of oxygen is brought about. The recent observations of Draper and of Pfeffer have shown that in this action the solar spectrum is not equally effective in all its parts; that the yellow and least refrangible rays are those which act with the most intensity; that the violet and other highly refrangible rays of the visible spectrum take but a very subordinate part in assimilation; and that the invisible rays which lie beyond the violet are totally inoperative. In almost every grain of chlorophyl one or more starch granules may be seen. This starch is chemicall isomeric with the cellulose cell wall, with woody fiber, a..d other hard parts of plants, and is one of the most important products of assimilation. When plants whose chlorophyl contains starch are left for a sufficient time in darkness, the starch is absorbed and completely disappears: but when they are restored to the light the starch reappears in the chlorophyl of the cells.

NO DUALISM IN LIFE.

With this dependence of assimilation on the presence of chlorophyl a new physiological division of labor is introduced into the life of plants. In the higher plants, while the work of assimilation is allocated to the chlorophyl-containing cells, that of cell division and growth devolves on another set of cells, which, lying deeper in the plant, are removed from the direct action of light, and in which chlorophyl is therefore never produced. In certain lower plants, in consequence of their simplicity of structure and the fact that all the cells are equally exposed to the influence of light, this physiological division of labor shows itself in a somewhat different fashion. Thus in some of the simple green algæ, such as *Spirogyra* and *Hydrodictyon*, assimilation takes place as in other cases during the day, while their cell division and growth take place chiefly, if not exclusively, at night. Strasburger, in his remarkable observations on cell division in *Spirogyra*, was obliged to adopt an artificial device in order to compel the *Spirogyra* to postpone the division of its cells to the morning. Here the functions of assimilation and growth devolve on one and the same cell, but while one of these functions is exercised only during the day, the time for the other is the night. It seems impossible for the same cell at the same time to exercise both functions, and these are here accordingly divided between different periods of the twenty-four hours. The action of the chlorophyl in bringing about the decomposition of carbonic acid is not, as was recently believed, absolutely confined to plants. In some of the lower animals, such as *Stentor* and other infusoria, the *Green Hydra*, and certain green planariæ and other worms, chlorophyl is differentiated in their protoplasm, and probably always acts here under the influence of light exactly as in plants. Indeed, it has been proved by some recent researches of Mr. Geddes, that the green planarias when placed in water and exposed to the sunlight give out bubbles of gas which contain from 44 to 55 per cent. of oxygen. Mr. Geddes has further shown that these animals contain granules of starch in their tissues, and in this fact we have another striking point of resemblance between them and plants. A similar approximation of the two organic kingdoms has been shown by the beautiful researches of Mr. Darwin—confirmed and extended by his son, Mr. Francis Darwin—on Drosera and other so-called carnivorous plants. These researches, as is now well-known, have shown that in all carnivorous plants there is a mechanism fitted for the capture of living prey, and that the animal matter of the prey is absorbed by the plant after having been digested by a secretion which acts like the gastric juice of animals. Again, Nägeli has recently shown that the cell of the yeast fungus contains about 2 per cent. of peptine, a substance hitherto known only as the product of the digestion of azotized matter by animals. Indeed, all recent research has been bringing out in a more and more decisive manner the fact that there is no dualism in life—that the life of the animal and the life of the plant are—like their protoplasm, in all essential points identical. But there is, perhaps, nothing which shows more strikingly the identity of the protoplasm in plants and animals, and the absence of any deep-pervading difference between the life of the animal and that of the plant, than the fact that plants may be placed, just like animals, under the influence of anæsthetics. When the vapor of chloroform or of ether is inhaled by the human subject, it passes into the lungs, where it is absorbed by the blood, and thence carried by the circulation to all the tissues of the body. The first to be affected by it is the delicate nervous element of the brain, and loss of consciousness is the result. If the action of the anæsthetic be continued, all the other tissues are in their turn attacked by it and their irritability arrested. A set of phenomena entirely parallel to these may be presented by plants.

PROTOPLASM AFFECTED BY ANÆSTHETICS.

We owe to Claude Bernard a series of interesting and most instructive experiments on the action of ether and chloroform on plants. He exposed to the vapor of ether a healthy and vigorous sensitive plant, by confining it under a bell-glass into which he introduced a sponge filled with ether. At the end of half an hour the plant was in a state of anæsthesia; all its leaflets remained fully extended, but they showed no tendency to shrink when touched. It was then withdrawn from the influence of the ether, when it gradually recovered its irritability, and finally responded as before to the touch. It is obvious that the irritability of the protoplasm was here arrested by the anæsthetic, so that the plant became unable to give a response to the action of an external stimulus. It is not, however, the irritability of the protoplasm of only the motor elements of plants that anæsthetics are capable of arresting. These may act also on the protoplasm of those cells whose function lies in chemical synthesis, such as is manifested in the phenomena of the germination of the seed, and in nutrition generally, and Claude Bernard has shown that germination is suspended by the action of ether or chloroform. Seeds of cress, a plant whose germination is very rapid, were placed in conditions favorable to a speedy germination, and while thus placed were exposed to the vapor of ether. The germination, which would otherwise have shown itself by the next day, was arrested. For five or six days the seeds were kept under the influence of the ether, and showed during this time no disposition to germinate. They were not killed, however, they only slept, for on the substitution of common air for the etherized air with which they had been surrounded, germination at once set in and proceeded with activity. Experiments were also made on that function of plants by which they absorb carbonic acid and exhale oxygen, and which, as we have already seen, is carried on through the agency of the green protoplasm or chlorophyl, under the influence of light—a function which is commonly but erroneously called the respiration of plants. Aquatic plants afford the most convenient subjects for such experiments. If one of these be placed in a jar of water holding ether or chloroform in solution, and a bell-glass be placed over the submerged plant, we shall find that the plant no longer absorbs carbonic acid or emits oxygen. It remains, however, quite green and healthy. In order to awaken the plant, it is only necessary to place it in non-etherized water, when it will begin once more to absorb carbonic acid, and oxhale oxygen under the influence of sunlight.

The same great physiologist has also investigated the action of anæsthetics on fermentation. It is well-known that alcoholic fermentation is due to the presence of a minute fungus, the yeast fungus, the living protoplasm of whose cells has the property of separating solutions of sugar into alcohol, which remains in the liquid, and carbonic acid, which escapes into the air. Now, if the yeast plant be placed along with sugar in etherized water it will no longer act as a ferment. It is anæsthesiated, and cannot respond to the stimulus which, under ordinary circumstances, it would find in the presence of the sugar. If, now, it be placed on a filter, and the ether washed completely away, it will, on restoration to a saccharine liquid, soon resume its duty of separating the sugar into alcohol and carbonic acid. Claude Bernard has further called attention to a very significant fact which is observable in this experiment. While the proper alcoholic fermentation is entirely arrested by the etherization of the yeast plant, there still goes on in the saccharine solution a curious chemical change, the cane sugar of the solution being converted into grape sugar, a substance identical in its chemical composition with the cane sugar, but different in its molecular constitution. Now, it is well known from the researches of Bertholet, that this conversion of cane sugar into grape sugar is due to a peculiar inversive ferment, which, while it accompanies the living yeast plant, is itself soluble and destitute of life. Indeed, it has been shown that in its natural conditions the yeast fungus is unable of itself to assimilate cane sugar, and that in order that this may be brought into a state fitted for the nutrition of the fungus, it must be first digested and converted into grape sugar, exactly as happens in our own digestive organs. To quote Claude Bernard's graphic account: "The fungus ferment has thus beside it in the same yeast a sort of servant given by nature to effect this digestion. The servant is the unorganized inversive ferment. This ferment is soluble, and as it is not a plant, but an unorganized body destitute of sensibility, it has not gone to sleep under the action of the ether, and thus continues to fulfill its task." In the experiment already recorded on the germination of seeds the interest is by no means confined to that which attaches itself to the arrest of the organizing functions of the seed, those, namely, which manifest themselves in the development of the radicle and plumule and other organs of the young plant. Another phenomenon of great significance becomes at the same time apparent—the anæsthetic exerts no action on the concomitant chemical phenomena which in germinating seeds show themselves in the transformation of starch into sugar under the influence of diastase (a soluble and non-living ferment which also exists in the seed), and the absorption of oxygen with the exhalation of carbonic acid. These go on as usual, the anæsthesiated seed continuing to respire, as proved by the accumulation of carbonic acid in the surrounding air. The presence of the carbonic acid was rendered evident by placing in the same vessel with the seeds which were the object of the experiment a solution of barytes, when the carbonate became precipitated from the solution in quantity equal to that produced in a similar experiment with seeds germinating in unetherized air. So, also, in the experiment which proves the faculty possessed by the chlorophyllian cells of absorbing carbonic acid and exhaling oxygen under the influence of light may be arrested by anæsthetics, it could be seen that the plant, while in a state of anæsthesia, continued to respire in the manner of animals; that is, it continued to absorb oxygen and exhale carbonic acid. This is the true respiratory function which was previously masked by the predominant function of assimilation, which devolves on the green cells of plants, and which manifests itself under the influence of light in the absorption of carbonic acid and the exhalation of oxygen. It must not, however, be supposed that the respiration of plants is entirely independent of life. The conditions which bring the oxygen of the air and the combustible matter of the respiring plant into such relations as may allow them to act on one another are still under its control, and we must conclude that in Claude Bernard's experiment the anæsthesia had not been carried so far as to arrest such properties of the living tissues as are needed for this. The quite recent researches of Schützenberger, who has investigated the process of respiration as it takes place in the cell of the yeast fungus, have shown that vitality is a factor in this process. He has shown that fresh yeast, placed in water, breathes like an aquatic animal, disengaging carbonic acid, and causing the oxygen contained in the water to disappear. That this phenomenon is a function of the living cell is proved by the fact that, if the yeast be first heated to 60°C., and then placed in the oxygenated water, the quantity of oxygen in the water remains unchanged; in other words, the yeast ceases to breathe. Schützenberger has further shown that light exerts no influence on the respiration of the yeast cell—that the absorption of oxygen by the cell takes place in the dark exactly as in sunlight. On the other hand, the influence of temperature is well marked. Respiration is almost entirely arrested at temperatures below 10° C., it reaches its maximum at about 40° C., while at 60° C. it again ceases. All this proves that the respiration of living beings is identical, whether manifested in the plant or in the animal. It is essentially a destructive phenomenon—as much so as the burning of a piece of charcoal in the open air, and, like it, is characterized by the disappearance of oxygen and the formation of carbonic acid. One of the most valuable results of the recent careful application of the experimental method of research to the life phenomena of plants is thus the complete demolition of the supposed antagonism between respiration in plants and that in animals.

THE FUNDAMENTAL DIFFERENCES IN PROTOPLASM.

I have thus endeavored to give you in a few broad outlines a sketch of the nature and properties of one special modification of matter, which will yield to none other in the interest which attaches to its study, and in the importance of the part allocated to it in the economy of nature. Did the occasion permit, I might have entered into many details which I have left untouched; but enough has been said to convince you that in protoplasm we find the only form of matter in which life can manifest itself; and that, though

the outer conditions of life—heat, air, water, food—may all be present, protoplasm would still be needed, in order that these conditions may be utilized, in order that the energy of lifeless nature may be converted into that of the countless multitudes of animal and vegetable forms which dwell upon the surface of the earth or people the great depths of its seas. We are thus led to the conception of an essential unity in the two great kingdoms of organic Nature—a structural unity, in the fact that every living being has protoplasm as the essential matter of every living element of its structure; and a physiological unity, in the universal attribute of irritability which has its seat in this same protoplasm, and is the prime mover of every phenomenon of life. We have seen how little mere form has to do with the essential properties of protoplasm. This may shape itself into cells, and the cells may combine into organs in ever increasing complexity, and protoplasm force may be thus intensified, and, by the mechanism of organization, turned to the best possible account; but we must still go back to protoplasm as a naked formless plasma if we would find—freed from all non-essential complications—the agent to which has been assigned the duty of building up structure and of transforming the energy of lifeless matter into that of living. To suppose, however, that all protoplasm is identical where no difference cognizable by any means at our disposal can be detected would be an error. Of two particles of protoplasm, between which we may defy all the power of the microscope, all the resources of the laboratory, to detect a difference, one can develop only to a jelly-fish, the other only to a man, and one conclusion alone is here possible—that deep within them there must be a fundamental difference which thus determines their inevitable destiny, but of which we know nothing, and can assert nothing beyond the statement that it must depend on their hidden molecular constitution. In the molecular condition of protoplasm there is probably as much complexity as in the disposition of organs in the most highly differentiated organisms; and between two masses of protoplasm, indistinguishable from one another, there may be as much molecular difference as there is between the form and arrangement of organs in the most widely-separated animals or plants. Herein lies the many-sidedness of protoplasm; herein lies its significance as the basis of all morphological expression, as the agent of physiological work, while in all this there must be an adaptiveness to purpose as great as any claimed for the most complicated organism.

LIFE A PROPERTY OF PROTOPLASM.

From the facts which have been now brought to your notice there is but one legitimate conclusion—that life is a property of protoplasm. In this assertion there is nothing that need startle us. The essential phenomena of living beings are not so widely separated from the phenomena of lifeless matter as to render it impossible to recognize an analogy between them; for even irritability, the one grand character of all living beings, is not more difficult to be conceived of as a property of matter than the physical phenomena of radial energy. It is quite true that between lifeless and living matter there is a vast difference, a difference greater far than any which can be found between the most diverse manifestations of lifeless matter. Though the refined synthesis of modern chemistry may have succeeded in forming a few principles which until lately had been deemed the proper product of vitality, the fact still remains that no one has ever yet built up one particle of living matter out of lifeless elements—that every living creature, from the simplest dweller on the confines of organization up to the highest and most complex organism, has its origin in pre-existent living matter—that the protoplasm of to-day is but the continuation of the protoplasm of other ages, handed down to us through periods of indefinable and indeterminable time. Yet with all this, vast as the difference may be, there is nothing which precludes a comparison of the properties of living matter with those of lifeless. When, however, we say that life is a property of protoplasm, we assert as much as we are justified in doing. Here we stand upon the boundary between life in its proper conception, as a group of phenomena having irritability as their common bond, and that other and higher group of phenomena which we designate as consciousness or thought, and which, however intimately connected with those of life, are yet essentially distinct from them. When the heart of a recently killed frog is separated from its body and touched with the point of a needle, it begins to beat under the excitation of the stimulus, and we believe ourselves justified in referring the contraction of the cardiac fibers to the irritability of their protoplasm as its proper cause. We see in it a remarkable phenomenon, but one nevertheless in which we can see unmistakable analogies with phenomena purely physical. There is no greater difficulty in conceiving of contractility as a property of protoplasm than there is in conceiving of attraction as a property of the magnet.

IS THOUGHT A PROPERTY OF PROTOPLASM?

When a thought passes through the mind, it is associated, as we have now abundant reason for believing, with some change in the protoplasm of the cerebral cells. Are we, therefore, justified in regarding thought as a property of the protoplasm of these cells, in the sense which we regard muscular contraction as a property of the protoplasm of muscle? or is it really a property residing in something far different, but which may yet need for its manifestations the activity of cerebral protoplasm? If we could see any analogy between thought and any one of the admitted phenomena of matter, we should be bound to accept the first of these conclusions as the simplest, and as affording a hypothesis most in accordance with the comprehensiveness of natural laws; but between thought and the physical phenomena of matter there is not only no analogy, but there is no conceivable analogy; and the obvious and continuous path which we have hitherto followed up in our reasonings from the phenomena of lifeless matter through those of living matter here comes suddenly to an end. The chasm between unconscious life and thought is deep and impassable, and no transitional phenomena can be found by which as by a bridge we may span it over; for even from irritability, to which, on a superficial view, consciousness may seem related, it is as absolutely distinct as it is from any of the ordinary phenomena of matter. It has been argued that because physiological activity must be a property of every living cell, psychical activity must be equally so, and the language of the metaphysician has been carried into biology, and the "cell soul" spoken of as a conception inseparable from that of life. That psychical phenomena, however, characterized as they essentially are by consciousness, are not necessarily coextensive with those of life, there cannot be a doubt. How far back in the scale of life consciousness may exist we have as yet no means of determining, nor is it necessary for our argument that we should. Certain it is that many things, to all appearance the result of volition, are capable of being explained as absolutely unconscious acts; and when the swimming swarm spore of an alga avoids collision, and by a reversal of the stroke of its cilia backs from an obstacle lying in its course, there is almost certainly in all this nothing but a purely unconscious act. It is but a case in which we find expressed the great law of the adaptation of living beings to the conditions which surround them. The irritability of the protoplasm of the ciliated spore responding to an external stimulus sets in motion a mechanism derived by inheritance from its ancestors, and whose parts are correlated to a common end—the preservation of the individual. But even admitting that every living cell were a conscious and thinking being, are we therefore justified in asserting that its consciousness like its irritability is a property of the matter of which it is composed? The sole argument on which this view is made to rest is that from analogy. It is argued that because the life phenomena, which are invariably found in the cell, must be regarded as a property of the cell, the phenomena of consciousness by which they are accompanied must be also so regarded. The weak point in the argument is the absence of all analogy between the things compared, and as the conclusion rests solely on the argument from analogy, the two must fall to the ground together.

In a lecture to which I once had the pleasure of listening—a lecture characterized no less by lucid exposition than by the fascinating form in which its facts were presented to the hearers, Professor Huxley argues that no difference, however great, between the phenomena of living matter and those of the lifeless elements of which this matter is composed should militate against our attributing to protoplasm the phenomena of life as properties essentially inherent in it; since we know that the result of a chemical combination of physical elements may exhibit physical properties totally different from those of the elements combined; the physical phenomena presented by water, for example, having no resemblance to those of its combining elements, oxygen and hydrogen. I believe that Professor Huxley intended to apply this argument only to the phenomena of life in the stricter sense of the word. As such it is conclusive. But if it be pushed further, and extended to the phenomena of consciousness, it loses all its force. The analogy, perfectly valid in the former case, here fails. The properties of the chemical compound are like those of its components, still physical properties. They come within the wide category of the universally accepted properties of matter, while those of consciousness belong to a category absolutely distinct—one which presents not a trace of a connection with any of those which physicists have agreed in assigning to matter as its proper characteristics. The argument thus breaks down, for its force depends on analogy alone, and here all analogy vanishes. That consciousness is never manifested except in the presence of cerebral matter or of something like it, there cannot be a question; but this is a very different thing from its being a property of such matter in the sense in which polarity is a property of the magnet, or irritability of protoplasm. The generation of the rays which lie invisible beyond the violet in the spectrum of the sun cannot be regarded as the property of the medium which by changing their refrangibility can alone render them apparent. I know that there is a special charm in those broad generalizations which would refer many very different phenomena to a common source. But in this very charm there is undoubtedly a danger, and we must be all the more careful lest it should exert an influence in arresting the progress of truth, just as at an earlier period traditional beliefs exerted an authority from which the mind but slowly and with difficulty succeeded in emancipating itself. But have we, it may be asked, made in all this one step forward toward an explanation of the phenomena of consciousness or the discovery of its source? Assuredly not. The power of conceiving of a substance different from that of matter is still beyond the limits of human intelligence, and the physical or objective conditions which are the concomitants of thought are the only ones of which it is possible to know anything, and the only ones whose study is of value. We are not, however, on that account forced to the conclusion that there is nothing in the universe but matter and force. The simplest physical law is absolutely inconceivable by the highest of the brutes, and no one would be justified in assuming that man had already attained the limit of his powers. Whatever may be that mysterious bond which connects organization with psychical endowments, the one grand fact—a fact of inestimable importance—stands out cleared and freed from all obscurity and doubt, that from the first dawn of intelligence there is with every advance in organism a corresponding advance in mind. Mind as well as body is thus traveling onwards through higher and still higher phases; the great law of evolution is shaping the destiny of our race; and though now we may at most but indicate some weak point in the generalization which would refer consciousness as well as life to a common material source, who can say that in the far off future there may not yet be evolved other and higher faculties from which light may stream in upon the darkness, and reveal to man the great mystery of Thought?

ON THE ACTION OF MAGNETS ON LIQUID JETS.*

By SILVANUS P. THOMPSON, B.A., D.Sc., Professor of Experimental Physics in University College, Bristol.

IN studying the phenomena of the voltaic arc, the author has been led to inquire into the actions produced by magnets upon movable conductors, such as jointed wires, flexible metallic leaves, liquid conductors, gases in high rarefaction, flames, and liquid jets, traversed by currents.

Nearly all the phenomena of rotations and translations due to electro-dynamic and electro-magnetic attraction or repulsion have been demonstrated to hold good for liquid conductors, both those which possess metallic conductivity and those which possess only electrolytic conductivity. Davy, Casselmann, and Walker have shown the electric arc to behave as a mobile conductor. Plücker and De la Rive, and more recently Crookes, have observed the existence of these electro-dynamic actions on the luminous discharges in highly rarefied media, and which appear to be electric convection currents rather than electric currents proper.

The author has examined the case of liquid veins, both of dilute acid and of mercury traversed by currents, and finds that these, when subjected to the action of powerful magnets, exhibit analogous motions of translation, rotation, etc. Thus a liquid vein carrying a current between the poles of a horizontal horseshoe electro-magnet no longer falls straight, but is thrust aside and falls down an inverted curve. A vein falling in front of the pole of a vertical magnet is likewise drawn aside, tending to become parallel to the hypothetical Ampèrian currents, and to rotate in an opposed sense around the pole. Further, a liquid vein carrying a current falling upon the pointed pole of a vertical magnet is twisted, the sense of the torsion depending on the direction of the current and the polarity of the magnet. The author has also essayed to extend his observations to the case of liquid jets which break in the air, and which, therefore, cannot carry electric currents proper, but only electric convection currents, and the results obtained, though not yet completed, dispose him to include in this act of phenomena the so-called diamagnetism of flames and of jets of smoke and steam.

* Paper read before Section A of the British Association at Sheffield, August, 1879.

NOTES ON STRONG ALKALINE DEVELOPERS.

IN 1873 I wrote as to emulsifying bromide of silver in collodion, and never found any difficulty in doing so, provided I mixed them thoroughly in a mortar, adding the one little by little to the other. It required knack and somewhat delicate manipulation, but the result was very satisfactory. So with gelatine I act in the same way, and with no drawback; still at present I prefer other methods of preparation.

I believe many negatives are lost from the want of studying the science of development. If room can be found for a reprint of a paper published by me in 1874 it will be found to bear exactly on the work of the present day:

"The differences to be found in the use of developers of various strengths is a subject to which sufficient prominence has not hitherto been given; and while much has been written on the component parts of an emulsion, but little notice has been taken of the fact that with the same emulsion, or same bath process, an endless variety of negatives or transparencies can be produced, and thus to those who use a strong alkaline developer the following hints will be of use:

"If your negatives are coming too dense, reduce the amount of pyrogallic acid in your developer; if your plates, on the contrary, are wanting in density, increase the strength of the pyrogallic acid, adding, in the latter case, a drop or two more bromide to control the increased energy of the developer.

"The plate is very nearly as sensitive with a weak solution of pyro as with a strong one, and the development is under great control, as by adding a few drops of pyro from time to time (having commenced with the maximum of strong ammonia) the plate can be worked up to any required density. When liquid ammonia is used in the developer the pyro and bromide should be applied to the plates before adding the ammonia to the developing solution.

"A modification that I have found of great value during the past summer has been the use of a preparation of gelatine in the alkaline developer. It enables one greatly to reduce the amount of bromide, and, indeed, if necessary, to dispense with it altogether, as the gelatine has a great restraining power over the action of the ammonia, and does not, as bromide does, interfere with the production of detail. Gelatine also gives a beautiful deposit on the negative, and any one having once used gelatine will, I think, adopt it for his future work.

"Tannin and gallic acid can also be used in the developer to replace bromide; but the quality and character of a negative developed with gelatine made me prefer that substance to either of the two last mentioned. You will remember that when gelatine was added to the iron developer some years since it tended to produce a harder and denser negative than one developed with the ordinary iron developer, and, moreover, the plate required a longer exposure in the camera. The action of gelatine in the alkaline developer is, as nearly as possible, the reverse of all these conditions.

"Another subject which I have worked out is fuming by ammonia as a means of developing dry plates, and with the gelatino-bromide process I find great advantage in its use.

"The less a gelatine film has to do with water the better; and I prefer to develop a gelatino-bromide plate by pouring on it, to commence with, a developer composed of glycerine and water, or gelatine and water, and to which the necessary bromide and pyrogallic acid are added as usual. It is then put into the box and fumed, and a brilliant and perfect image very rapidly appears."—*H. Stuart Wortley, in Journal of the Photographic Society.*

ACTION OF LIGHT UPON BATTERIES.

By H. PELLAT.

A DANIELL element whose copper is very clean is quite insensible to light. It is not the same if the copper is modified by oxidation or by the formation of a salt on its surface. Two Daniell elements were prepared as standards of electromotoric force, the sulphates being contained in the two concentric glass vessels. These elements, perfectly transparent, were kept for five months; the zinc was not affected, but the copper became coated with verdigris. Nevertheless, the elements retained their original force when the measurement was effected in the shade, but, on exposure to the sun, it was diminished by one-fortieth of its value. This variation ceased when the sun's rays were intercepted by a screen. This phenomenon is not due to a rise of heat, for the immersion of the battery in water at 50° produced no sensible effect, and a red glass which transmitted half the solar thermic radiations acted like an opaque screen. The luminous action renders the copper less positive

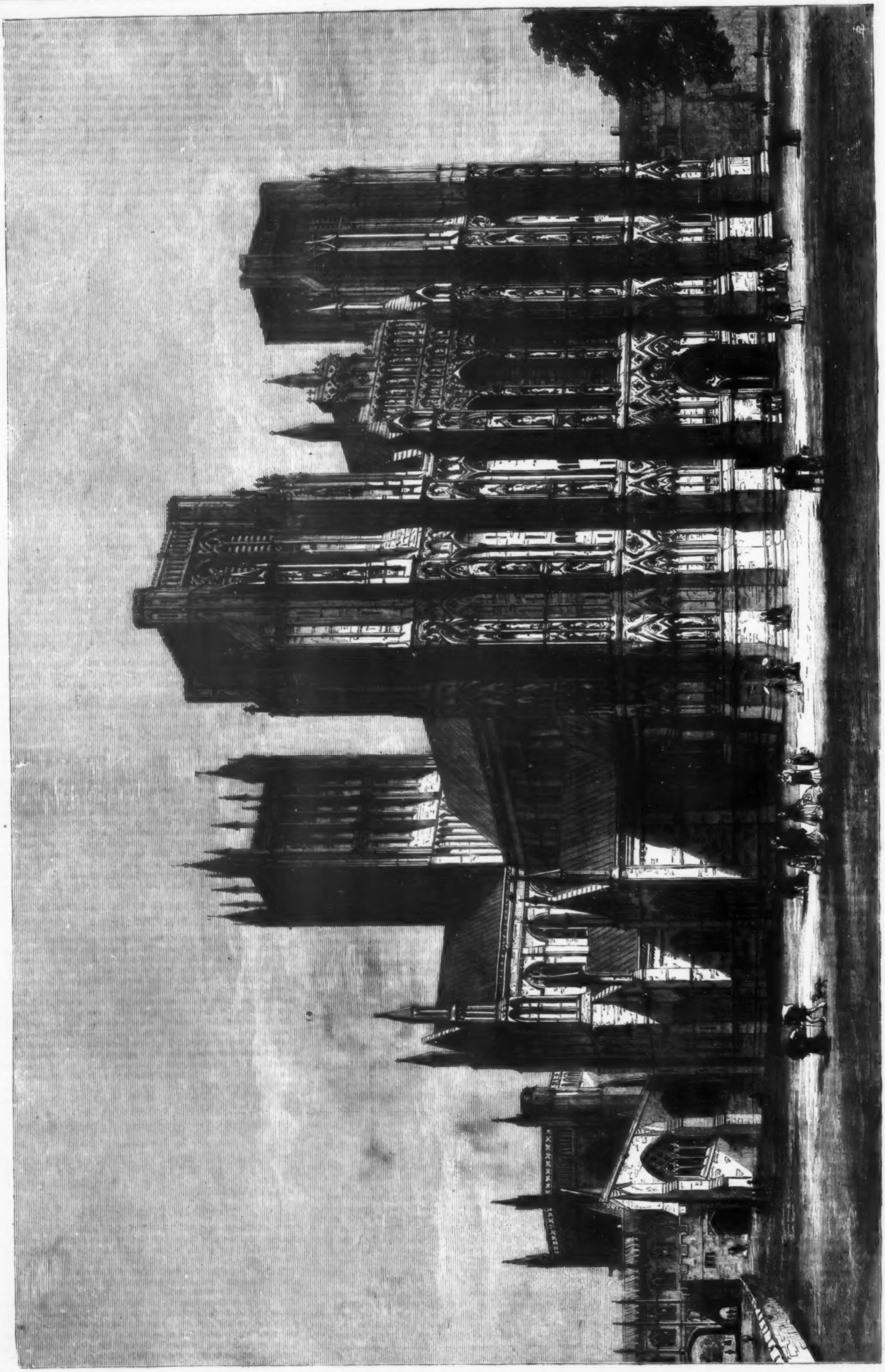
FORMATION OF OZONE BY HYDROCARBONS.

By J. SCHIEL.

IT has been observed that the alkaline metals, thallium, etc., do not retain their brightness if kept in a stoppered bottle under rock oil. The author proves that this action is due to the formation of ozone.

TO DESTROY RED SPIDERS.

FILL a barrel nearly full of water, slake in it about a quarter of a peck of lime, and let it stand until perfectly clear. Hold the plants in the water, bottom up, for about five or ten minutes, then wash them with pure water. A little flour of sulphur dusted over and under the leaves is also efficacious. Separate those that are infested from those not touched; do so as soon as you discover them. They will always be found on the underside of the leaves. The plants should be taken from the window to a place where water can be used freely. Lay each on its side in the sink, and pour water over and upon it, and keep doing so as long as red spiders can be seen. Doing this once or twice a week thereafter will be a good preventive of their return.—*Western Farmer.*



WELLS CATHEDRAL.

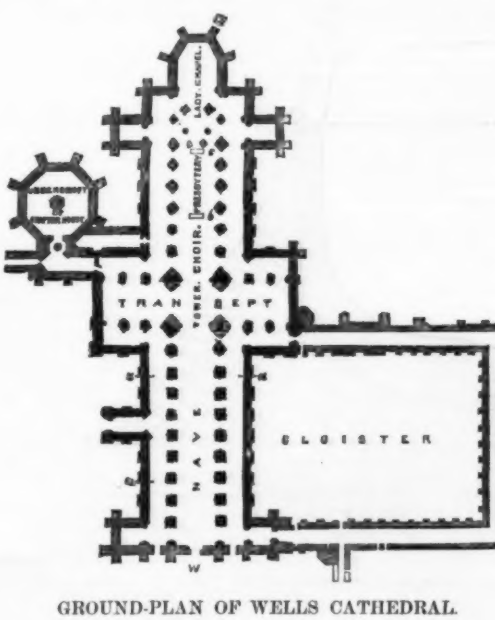
WELLS CATHEDRAL.

The Royal Archæological Institute lately met at Taunton, and made its excursion to Wells.

It was King Ina, in the year 704, who founded a college of canons at Wells. That name was derived from a spring of reputed miraculous healing efficacy, dedicated to St. Andrew. Two hundred years later, in the reign of Edward the Elder, a bishopric of Wells was created. Its first occupants were translated from the neighboring Abbey of Glastonbury. The French Bishop John de Villula, some time after the Norman Conquest, removed the see to Bath. There was much dispute about this, till it was resolved, after a few years, to style the diocese "of Bath and Wells." The Bishop was thenceforth elected by an equal vote of monks in Bath Abbey and Canons of Wells. The cathedral, as it now stands at Wells, was begun in 1214 by Bishop Jocelyne Trotman. Its west front is adorned with three hundred sculptured figures of saints and angels, apostles, kings and queens, princes, prelates, knights and nobles, and with groups representing actions of Bible history. This magnificent front, with its supporting towers and the north transept and tower, also the exterior of the choir and the chapter house, are shown in the fine view drawn by Mr. S. Read for the *Illustrated London News*. Its architecture is that of the early part of the thirteenth century.

For the plan and the following additional particulars, we are indebted to the *Building News:*

On entering the town we look up at the unrivaled west front of the cathedral, with its tiers of crumbling statues, set in rich although roughly executed paneling, over the whole façade, and turned over the angles of the flanking towers. Of the three hundred figures not one can be with certainty identified, although there can scarcely be a doubt that the Te Deum of Ambrose was intended to be represented. The lowest tier is almost vacant, but shows traces of full length statues beneath canopies; above are quatrefoils filled, according to the late Prof. Cockerell, with angelic figures; over these a series of Biblical subjects; then come two tiers of full length statues, and a sixth tier is occupied by small figures representing the final Resurrection. In the central gable are the angels, the twelve apostles, and the feet of what must have been our Saviour in majesty. A scheme has long been in contemplation for filling up the vacant niches, and to this little objection can be raised if the sculpture is of equal merit to that of the late E. L. Redfern, at Salisbury. A singular effect is given to the front by the slender shafts of Purbeck, now bleached to a slate color, which are brought forward on the buttresses between the niches. The unprecedented width of the west façade is due to the fact that the towers stand beyond the aisles. The southern steeple is proved by the documentary evidence to be about half a century later than the other, but the style has been so well followed that it is not easy to trace the changes introduced in the details. Further examination of these western towers confirms the impression that though admirably proportioned so as to harmonize with the west front, with the general mass of the cathedral, and with the central tower, they end too abruptly. There is no sign that any addition to the masonry was ever intended, and Mr. Freeman's suggestion, that it was proposed to cap them with pinnacles and spires of wood covered with lead, appears to be justified by the facts and by other examples.



GROUND-PLAN OF WELLS CATHEDRAL.

Passing round to the north side for a general survey of the exterior, the archaic north porch in center of nave side, and the charming covered bridge or "chain-gate" thrown across the road from the chapter house and north transept to the Vicar's Close, deserve attention. Around the whole cathedral runs a simply treated 14th century parapet, binding the whole into one composition. The octagonal chapter house, with rich traceried lights, separated by pinnacled buttresses and open parapet, and its singular staircase, is of a beauty only surpassed in its kind by the groined interior of this adjunct, with fan-like vaulting springing from central pillar. Scott's restoration at Westminster, although evidently reconstructed on this model to an enlarged scale, appears scarcely equal to it in beauty. The alteration to decorated style of the three eastern bays of the choir from the earlier work of the three western ones is very marked in the fenestration, walling, and roofing. The Lady chapel is a low, irregular pentagon, joined to the choir by a short corridor, and from this point the richly ornamented central tower is seen to rise with grace from the roof. A walk into the extensive cloisters on the south side of nave completes the circuit of the cathedral. They are but of three sides, and are filled with memorial tablets, chiefly modern.

But before entering the cathedral some reference should be made to the historical sequence of its development. From the plan, which we reproduce by the courtesy of Messrs. Macmillan, the publishers, from Mr. E. A. Freeman's graphically written "History of the Cathedral Church of Wells," its compact and symmetrical arrangement, and the approximate dates of erection, can be seen. It consists of a nave of ten bays with aisles, the north and south transepts, each having north and south aisles, and of three bays each, an aisled choir of three bays, and beyond the retrochoir, and separately roofed, a Lady chapel. From the north transept a corridor leads to the octagonal chapter house, and the whole south side of nave is flanked by the cloisters. The original Saxon church seems to have been rebuilt, or more probably, greatly repaired, by Bishop Robert between 1135 and 1166. Less than forty years after, however, Bishop Jocelyne determined to recast the whole on a larger scale, and accordingly pulled it down, and commenced to re-erect it piecemeal, beginning, it is clear from the coursing of the masonry, at both the east and west ends, and the slight changes in design, that the gap of the fourth and fifth piers from the west end was bridged over last of all. At the same time, the three first bays of the choir and the transepts and the original cloister, then partly of wood, were in steady progress throughout the long episcopate of Jocelyne.

Whether the west front is earlier or later than the nave has been much disputed; that it is different in style and more like the work of Central England than the provincial workmanship of the nave can be seen at a glance; Prof. Willis and the late Richard J. King regarded it as a subsequent addition, but Messrs. J. H. Parker and E. A. Freeman believe it to be prior in date. Fifty-four years after Jocelyne's death, the "tholus," either the vault or central spire, fell in and did much damage. In 1286 the chapter appear to have completed their house, of which but the croft had been commenced. In 1321 the central tower was raised to its present height by Bishop Drokensford, and a few years later the Lady chapel was completed, the choir being soon afterward extended three bays eastward so as to meet it. The old choir was somewhat awkwardly adapted by recasing to the new work. As a church St. Andrew's was now complete, but the western towers were, as Mr. Freeman says, "mere stumps." The central tower had just been raised (in 1318-21) by three stages, and a "campanile" (? wooden spire) added, but signs of failure showed themselves in the piers, and to save it, the device was adopted which gives a unique effect to the internal view of Wells Cathedral. A low arch was turned across the nave, and another in each transept. Upon each of these an inverted arch was set, forming with the vaulting a gigantic pierced circle through which the roofs may be seen, and also the segmental openings of the spandrels were also left open. The adjoining arches of the clerestory and triforium were also blocked up. The eastern opening is closed by a stone screen. These works were completed in 1337-8. The last structural work was the raising of the towers. That in the south was the work of Bishop Harewood between 1366 and 1386, the other seems to have been carefully copied from it by the executors of Bishop Babwith in 1425, who also rebuilt the eastern cloister walk. The west and south sides were the work of Bishop Beckington in the middle of the 15th century.

The internal effect of the cathedral is very fine; but the edifice appears narrow and low in proportion to its length. The nave is of rich but somewhat rude early English character; the octagonal clustered piers have stiff foliage and birds in the caps. The whole emphasis of the effect is horizontal. The long line of the nave is well broken up by the perpendicular music gallery in the central bay and the shallow open work chantries between the second and third piers from the east end. During Mr. B. Ferrey's restoration of forty years ago the piers were cleaned from whitewash, and a somewhat wiry scroll pattern was stenciled in each of the lierne vaults. In the north transept is a singular astronomical clock of the 14th century (the works are modern), and on the north wall at right angles to this is a small wooden figure which strikes a bell. The choir is of great richness and beauty, its numerous arches of various sizes, the gilded groining, the stained windows with their elegant decorated tracery, the tabernacle work, and the lines of the Lady chapel seen through a low screen, uniting to produce a beautiful effect. The polychromatic decoration of the vault, executed by Salvin, is harmonious. In the choir aisle and north-east transept are several effigies.

The British Board of Trade statistics make more and more apparent, year by year, the fact that steamships are rapidly superseding sailing vessels both for home and foreign trade. In the foreign trade alone steam tonnage shows an increase of 10 per cent. in the last returns as compared with those of the preceding year, while a corresponding decrease is noticeable in sailing ships employed in the same trade.

A WAY OF PREVENTING STRIKES.

By James Parton.

I wonder men in a factory town should ever have the courage to strike; it brings such woe and desolation upon them all. The first few days, the cessation from labor may be a relief and a pleasure to a large number—a holiday, although a dull and tedious holiday, like a Sunday without any of the alleviations of Sunday—Sunday without Sunday clothes, Sunday bells, Sunday church, Sunday walks and visits. A painful silence reigns in the town. People discover that the factory bell calling them to work, though often unwelcome, was not a hundredth part as disagreeable as the silence that now prevails. The huge mills stand gaunt and dead; there is no noise of machinery, no puff of steam, no faces at the windows.

By the end of the first week the novelty has passed, and the money of some of the improvident families is running low. All are upon short allowance, the problem being to prolong life at the minimum of expense. The man goes without his meat, the mother without her tea, the children without the trifling inexpensive luxuries with which parental fondness usually treated them. Before the end of the second week a good many are hungry, and the workers begin to pine for employment. Their muscles are as hungry for exercise as their stomachs are for food. The provision dealers are more and more cautious about giving credit. The bank accounts, representing months or years of self-denying economy, begin to lessen rapidly, and careful fathers see that the bulwark which they have painfully thrown up to defend their children against the wolf are crumbling away a hundred times faster than they were constructed. If the strike lasts a month one half the population suffers every hour, and suffers more in mind than in body. Anxiety gnaws the soul. Men go about pale, gloomy, and despairing; women sit at home suffering even more acutely; until, at last, the situation becomes absolutely intolerable; and the strikers are fortunate indeed if they secure a small portion of the advance which they claimed.

Terrible as all this is. I am afraid we must admit that to just such miseries, sometimes nobly encountered, often heroically endured, the workingman owes a great part of the improvement in his condition which has taken place during the last seventy five years. A strike is like war. It should be the last resort. It never should be undertaken except after the longest deliberation, and when every possible effort has been made to secure justice by other means. In many instances it is better to submit to a certain degree of injustice than resort to a means of redress which brings most suffering upon the least guilty.

Does the reader know how the industrial classes were treated in former times? Mr. George Adcroft, president of an important co-operative organization in England, began life as a coal miner. He has recently given to Mr. Holyoake, author of the History of Co-operation, some information about the habits and treatment of English miners only forty years ago·

"They worked absolutely naked, and their daughters worked by their side. He and others were commonly compelled to work sixteen hours a day; and, from week's end to week's end, they never washed either hands or face. One Saturday night (he was then a lad of fifteen), he and others had worked till midnight, when there were still wagons at the pit's mouth. They had at last refused to work any later. The foreman told the employer, who waited till they were drawn up to the mouth, and beat them with a stout whip as they came to the surface."

So reports Mr. Holyoake, who could produce, if necessary, from the records of parliamentary investigations, many a ream of similar testimony. In truth, workingmen were scarcely regarded—nay, they were *not* regarded—as members of the human family. We find proof of this in the ancient laws of every country in Europe. In the reign of Edward VI. there was a law against idle workmen, which shows how they were regarded. Any laboring man or servant loitering or living idle for the space of three days, could be branded on the breast with the letter V (vagabond) and sentenced to be the slave of the person that arrested him for two years; and that person could "give him bread, water, or small drink, and refuse him meat, and cause him to work by beating, chaining, or otherwise." If he should run away from this treatment, he could be branded on the face with a hot iron with the letter S, and was to be the slave of his master for life.

Nor does there appear to have been any radical improvement in the condition of the workingman until within the memory of men now alive. When Robert Owen made his celebrated journey, in 1815, among the factory towns of Great Britain, for the purpose of collecting evidence about the employment of children in factories, he gathered facts which his son, who traveled with him, speaks of as being too terrible for belief.

"As a rule," says that son (Robert Dale Owen), "we found children of ten years old worked regularly fourteen hours a day, with but half an hour's interval for dinner, which was eaten in the factory. . . . Some mills were run fifteen, and in exceptional cases sixteen hours a day, with a single set of hands; and they did not scruple to employ children of both sexes from the age of eight. . . . Most of the overseers carried stout leather thongs, and we frequently saw even the youngest children severely beaten."

This, as recently as 1815! Mr Holyoake remarks himself that, in his youth, he never heard one word which indicated a kindly or respectful feeling between employers and employed, and he speaks of the workshops and factories of those days as *"charnel-houses of industry."* If there has been great improvement, we owe it chiefly to these causes: the resistance of the operative class; their growth in self-respect, intelligence, and sobriety; and the humanity and wisdom of some employers of labor.

The reader has, perhaps, seen an article lately printed in several newspapers entitled "Strikes and How to Prevent Them," by John Smedley, a stocking manufacturer of Manchester, who employs about eleven hundred persons. He is at the head of an establishment founded about the time of the American Revolution by his grandfather; and during all this long period there has never been any strike, nor even any disagreement, between the proprietors and the work-people.

"My ancestors' idea was," says Mr. Smedley, "that those who ride inside the coach should make those as comfortable as possible who are compelled, from the mere accident of birth, to ride outside."

That is the secret of it. Mr. Smedley mentions some of their modes of proceeding, one of which is so excellent that I feel confident it will one day be generally adopted in large factories. A cotton or woolen mill usually begins work in this country at half-past six, and frequently the operatives live half an hour's walk or ride from it. This obliges many

of the operatives, especially family men and women, to be up soon after four in the morning, in order to get breakfast, and be at the mill in time. It is the breakfast which makes the difficulty here. The meal will usually be prepared in haste and eaten in haste; late risers will devour it with one eye on the clock; and, of course, it cannot be the happy, pleasant thing a breakfast ought to be. But in Mr. Smedley's mill the people go to work at six without having had their breakfast. At eight the machinery stops, and all hands, after washing in a comfortable wash-room, assemble in what they call the dinner-house, built, furnished, and run by the proprietors. Here they find good coffee and tea for sale at two cents a pint, oatmeal porridge with sirup or milk at about ten cents a week, good bread and butter at cost.

In addition to these articles, the people bring whatever food they wish from home. The meal is enjoyed at clean, well-ordered tables. The employers keep in their service a male cook and female assistants, who will cook anything the people choose to bring. After breakfast, for fifteen minutes, the people knit, sew, converse, stroll out of doors, or amuse themselves in any way they choose. At half-past eight, the manager takes his stand at a desk in the great dinner-room, gives out a hymn, which the factory choir sings. Then he reads a passage from a suitable book, sometimes from the Bible, sometimes from some other book. Then there is a short prayer; then another hymn by the choir; after which all hands go to work, the machinery starting up again at nine.

There is similar accommodation for dinner, and at six work is over for the day. On Saturdays the mill is closed at half-past twelve, and the people have the whole afternoon for recreation. All the other rules and arrangements are in harmony with this exquisite breakfast scheme.

"We pay full wages," adds Mr. Smedley, "the hands are smart and effective. No man ever loses a day from drunkenness, and rarely can a hand be tempted to leave us. We keep a supply of dry stockings for those women to put on who come from a distance and get their feet wet; and every overlooker has a stock of waterproof petticoats to lend the women going a distance on a wet night."

I would like to cross the sea once more for the purpose of hugging John Smedley, and placing wreaths upon the tombs of his grandfather and father. He needed not have told us that whenever he goes through the shops all the people recognize him, and that it is a pleasure to him to be so recognized.

"I wish," he says, "I could make their lot easier, for, with all we can do, factory life is a hard one."—*New York Ledger*

AN OPEN POLAR SEA.

MR. M. O. PAVY, who has given much study to Arctic affairs, and is an ardent believer in the accessibility of the North Pole, recently laid his views before the St. Louis Academy of Sciences. Mr Pavy thought Captain Howgate's plans the best for reaching the pole, should the projected expedition in the Jeannette fail. He further suggested taking a passage around to the west of Behring's Straits. His readings of Frangel, Edenstorm, and other well-known Russian authorities, led him to believe in the open polar sea, and to doubt the existence of the much-talked-of poleocystic sea. The testimony of Captain Hall and Captain Tyson confirmed this theory. Commodore Maury and Captain Silas Bent and others were also believers in it. Mr. Pavy said that there was also a tradition on the coast of Siberia of a populated land away to the north, and that the people from this ice-girt region, when they landed on the Siberian coast, complained of chillness, saying their own country was much warmer. This tradition intensified Mr. Pavy's belief in the open polar sea. His idea was that the pole was surrounded by a sea, and this again girded by a circle of ice, which had so far been found impenetrable.

THE PROPOSED ISTHMUS SHIP RAILROAD.

By J. M. GOODWIN.

I IMAGINE that almost every American engineer who has read the letters of Captain Eads, and of Messrs. Chanute, Smith and Flad, printed in your issue of Aug. 8, and your comprehensive and suggestive editorial comments of the same date upon the subject matter of those letters, has felt an impulse toward giving the world at large, or at least that portion of the world immediately in his vicinage, the ideas that have formed in his mind after his more or less careful consideration of the proposition made by Captain Eads.

That impulse will, in most cases, be insufficient to carry the engineer through the labor of elaborating his ideas and putting them in writing; and in many cases the ideas, after having been confided to paper, will have no chance for being of service to the world, because they will not be given to the public. Perhaps some idea thus expressed, might, if seasonably communicated, prove of incalculable value to those who will have to design and perfect appliances for the work, and to overcome the very many difficulties that stand in the way of a satisfactory accomplishment of the great work to be undertaken.

I therefore urge civil and mechanical engineers, shipwrights, and mechanics generally, to speak out if they think that they have anything that will be of service to the enterprise, either as showing how a certain thing may be done, or as showing how and why a certain other thing must be avoided. Remember that once when a great engineering operation was about to end in disaster, at the critical moment an entirely unofficial and unprofessional person, in an entirely impulsive manner, cried out, "Wet the ropes!" and thereby was the saviour of the engineer of the undertaking as well as of the undertaking itself.

A chain of a thousand links may have nine hundred and ninety-nine perfect links, and yet fail because of a flaw in the thousandth link. Before the construction and satisfactory operation of the ship-railway will be possible, a thousand novel demands must be supplied by invention, or by modifications of known devices. The man who supplies only one link in this chain will contribute to the perfect whole as absolutely as he who supplies ten links.

In indorsing this, my exhortation, you, Mr. Editor, will, of course, bring upon yourself a considerable labor, but I am confident that the prospect of that labor will not deter you from seconding me.

As for myself, I desire to range myself with those who advocate the scheme for a ship railway rather than a canal across the Isthmus, on the grounds explicitly stated by Captain Eads and Mr. Flad: 1st, that, as compared with a canal, the railroad will cost very much less, and may be constructed in much less time; 2d, that the capacity of the railroad will be as great, or greater than that of the canal, and the cost of maintenance less.

Further, after the completion of sufficient surveys, and competent and through examination of the route adopted for the railroad, the cost of the road may be estimated with precision, while in the case of the canal, with its stupendous—what word is there that can adequately suggest its dimensions?—tunnel, and the almost interminable work along the line necessary to divert, or otherwise provide for, the surface-water and the water-courses intersected by the excavations, a limit to the cost can hardly be intelligently fixed. An estimate of the cost of the construction of a ship canal through a plain, gently undulating, but having nowhere any great elevation, and through a material almost uniform in quality, and nowhere such as to make blasting necessary, may be made with a reasonable precision, certain facts as to the cost of labor and material being known; but the problem present to the engineer who undertakes to estimate the cost of a ship canal to be carried, at the ocean level or otherwise, across the Isthmus of Panama, is one in which there is hardly one known quantity stated.

Confronted with the question as to how a vessel should be carried in her journey overland, we should consider that a ship is constructed with a view to the fact that her hull is to be sustained and held together by the pressure of the water in which she is to float, and that a large vessel when out of water will be strained and injured, except she be held in an upright position, with her keel and bilges uniformly supported.

We cannot maintain a road-bed, and the many lines of rails necessary to carry a car, supporting a ship and her cargo, in a true plane. Nor could we, if we wished to do so, make a car, to be long enough, and heavy and strong enough, to carry a loaded ship, that will not conform to all the twists in the surface of the road on which it may be moved. If we are to move our ship on wheels, at the rate of six or eight miles per hour, without straining her, we must move her *afloat*, and to do this must make a caisson, of a cross-section preferably as nearly like that of the ship as may be, and carry the ship in it, protected from jar and twist by what we may call a cushion of water. The caisson may be made of steel plates, and supported and arranged on a plan of which the subjoined sketch gives an idea. Three or four sizes of caisson would probably be used. A yacht like the "America," 98 feet long over all, may be carried in a "cradle," without the water cushion.

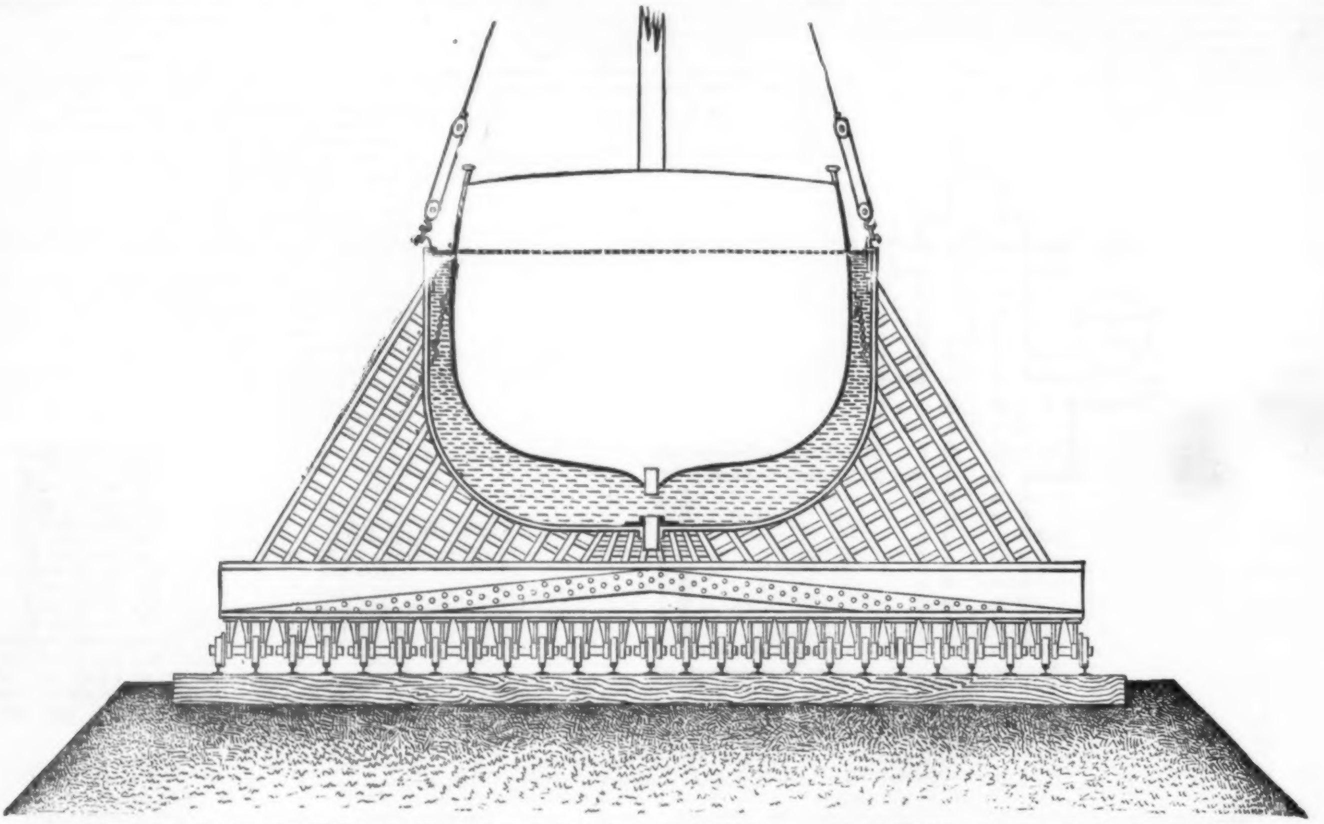
A ship of war of the Warrior type is 380 ft. long, 58 ft. beam, and 37½ ft. hold, and at a draught of 26 ft. has a displacement of 9,000 tons; her "wet surface" equals about 40,000 square ft.

The Niagara, U. S. N., is 330 ft. long, and 55 ft. beam, and at a draught of 23 ft. has a displacement of 5,440 tons.

The Twilight, clipper ship, has a length of 167 ft., beam 30 ft., and with a draught of 17½ ft. has a displacement of about 1,253 tons.

Two ships of the Twilight class may be carried in the caisson that is large enough for the Warrior class.

The caisson for the Warrior may be 390 × 60 ft., by 35 feet total depth. The ship draws 26 feet of water. Standing on a grade of one foot in a hundred, the caisson would be nearly four feet lower at one end than at the other. So we need to provide for at least 30 ft. of water in the caisson, and should have something to spare for leakage, so we will make the water 30 ft. deep *on a level*.



CRADLE FOR PROPOSED PANAMA SHIP RAILROAD.—DESIGNED BY J. M. GOODWIN.

If the caisson leaks, as it doubtless will, we replenish it from the large water pipe that will be laid along the road-bed, with hydrants and hose at convenient points.

When in the caisson the ship would be held from fore and aft movement by hawsers, and from rolling by preventer stays, made fast to chain plates on the shell of the caisson and to the ship's mast-heads. Elastic fenders would be fitted between sides of ship and the caisson.

I estimate for 184 sets of wheels, 25 wheels in a set, wheels to be 24 in. diameter; the outside ones only to be flanged. The axle to be 5 in. diameter, and the wheels all loose on the axles. The axle in sections connected by sleeves. If a wheel breaks we can jack up the truss under which the broken wheel is, and, after disconnecting the axle at the sleeve nearest the disabled wheel, slip the section of axle sidewise, and then, having slipped the new wheel over the free end of the axle, replace the whole.

The rails to carry the caisson and the engines to move it may be no heavier than 60 lb. per yard, but 70 lb. per yard would be better.

Changes in the direction of the road should be made by means of swing tables, long enough to receive the caisson, and the engines pushing and hauling it; the table to move on wheels set on radial axes. By continuing any tangent across the swing table, and about 600 feet beyond it, a *passing place* is provided. Fixed engines on the caisson-car, of which there would be four, would operate the gearing for moving the table with its load. An engine would be one of the fixtures of the swing table itself, but would be calculated to do no more than move the table when without load. The engines on the caisson-car would also be used in handling the caisson-gates and in working capstans and other gear.

The caisson-gates would be hinged at bottom, and the up-

per half of each gate would be made to telescope into the lower half.

The caisson would be stiffened by gunwales and bilge-strakes.

Locomotives for moving the caisson would run on the rails connected in the sketch by ~~. Gauge of tracks, five feet.

I estimate the weight of caisson and car:

	Tons.
Shells	550
Gates	250
Shores	1,000
Beams under trusses	672
Transverse trusses	936
Bridging between trusses	400
Gunwale and bilge strakes	200
Chain plates and rivets	25
Engines and boilers for operating gates and capstans, shops, tools, capstans, etc	316
Wheels	837½
Axles	530 6-10
Saddles and boxes	160 8-10
Total caisson and car	5,877 9-10 tons of 2,000 lb.
Add ship and load	9,000 "
Weight of water in caisson	3,446 "
Aggregate	18,324 tons;

and each wheel will have to carry 5,469 tons.

I estimate the cost of the caisson at $550,000.

On a gradient of 1 foot in 100 the resistance to traction would be about 550,000 lb., and 22 locomotives of 100,000 lb. each, all on drivers, would take the load along on the gradient specified, at the rate of six miles per hour, with a sufficient reserve of power to overcome the adverse force of a wind moving at the rate of 45 miles per hour, which would exert a pressure of about ten pounds per square foot of opposed surface, and would be rated as a "gale."

The locomotives would be placed ten in front and twelve behind. All would have steam driver-brakes, and some of the wheels of the caisson would be fitted with brakes to be operated by steam from the caisson-boilers.

To carry the 9,000 tons of freight moved in the caisson, allowing that each car would carry ten tons (net), 900 ordinary box cars would be employed; these cars would weigh, say, 9,000 tons, so the cars and load would weigh 18,000 tons against the 18,324 tons of caisson, *with its contained water* and its load.

To haul the 900 loaded cars on a gradient of 1 in 100, at 10 miles per hour, 40 ordinary freight engines would be employed.

The 40 engines would cost, now, about	$320,000
" 900 box cars " " " "	450,000
Total	$770,000
The caisson would cost, as per estimate	$550,000
" 22 heavy locomotives, about	220,000
Total	$770,000

We could load our ship into its caisson, haul her the 46 miles across the Isthmus, and put her into the water again, inside of fifteen hours, with a train crew not to exceed 60 men, all told; and this crew would do all the "terminal" work of loading and unloading. The train crews employed to run the 900 railroad cars, on the road supposed to have gradients of 52·8 ft. per mile, would aggregate 200 men, who would do none of the work of loading and unloading.

The 40 railroad trains would make, in fifteen hours (at 10 miles per hour) an aggregate of 6,000 train miles, and would accomplish work equal to carrying one ton of freight 1,350,000 miles.

The revenue from this haul would be, at one cent per ton per mile, $13,500, and the net earnings, under favorable circumstances, would be $5,400. The revenue of the ship railway company would be, at $2 per ton, $18,000 from the one train.

The ordinary (double track) freight railway of 150 miles in length *might* handle 9,000 tons of freight *each way* on its line daily; but it is not probable that it would haul more than the 9,000 tons through in any one direction. But the ship railway may in fifteen hours take out of water at least five ships, and have four "trains" in transit at one time in each direction. But suppose that the ship railway carried only *one* 9,000 ton load each way in a day; it would earn, at rate named, $36,000. The ordinary railroad, with 9,000 tons each way, would earn, at rate named, $27,000.

Now the double tracked railroad that can do the business named will have sidings equal in length to about 37 per cent. of the whole length of line; so it will have 355½ miles of *single* track altogether. If the whole road is laid with steel rail of 60 lb. per yard, the rails will represent an outlay of about $1,675,916. The ship railroad will require (as per sketch) 70 lb. rail, equal to 287½ miles of double track, and to 575 miles of single track. This rail, at the price assumed in the case of the ordinary road, will cost $3,162,500. The cost for rails, then, on the ordinary railroad is only about 53 per cent. of that shown for the ship railway. The extent of roadway and track to be maintained on the ordinary road is, however, about 62 per cent. of that shown for the ship railway. The gross revenue of the ordinary road is 75 per cent. of that of the ship railway in the case last assumed; its net earnings will be about 40 per cent. of its revenue.

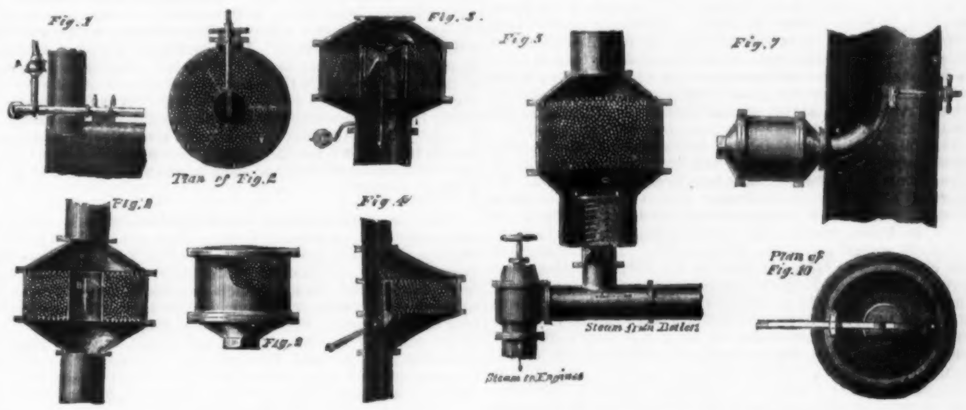
Now, as compared with the same items on the ship railway, the engine mileage on the ordinary railroad is *six* times as great, and the train crew aggregate *three and one-half times* as great, while the cost of handling and billing freight, which on the ordinary road is the *largest* item in its expense account, is on the ship railway entirely included in the cost of train crews.

If the area of track to be maintained on the ship railway is considerably greater than on the ordinary road, the cost of maintenance, per mile of two-rail track, will be considerably less. The rate of speed on the ship road will be low, while the weight carried per wheel will be no greater than on the ordinary road.

The cost of maintenance and operation of the ship road ought not to exceed 40 per cent. of its earnings. With 18,000 tons of freight per diem for 300 days in the year at the rate of $2 per ton, the road will earn $10,800,000 per annum, of which $6,480,000 should be net. This sum is 10 per cent. on $64,800,000, and the road, with all its appurtenances, need not cost that much.—*Railroad Gazette.*

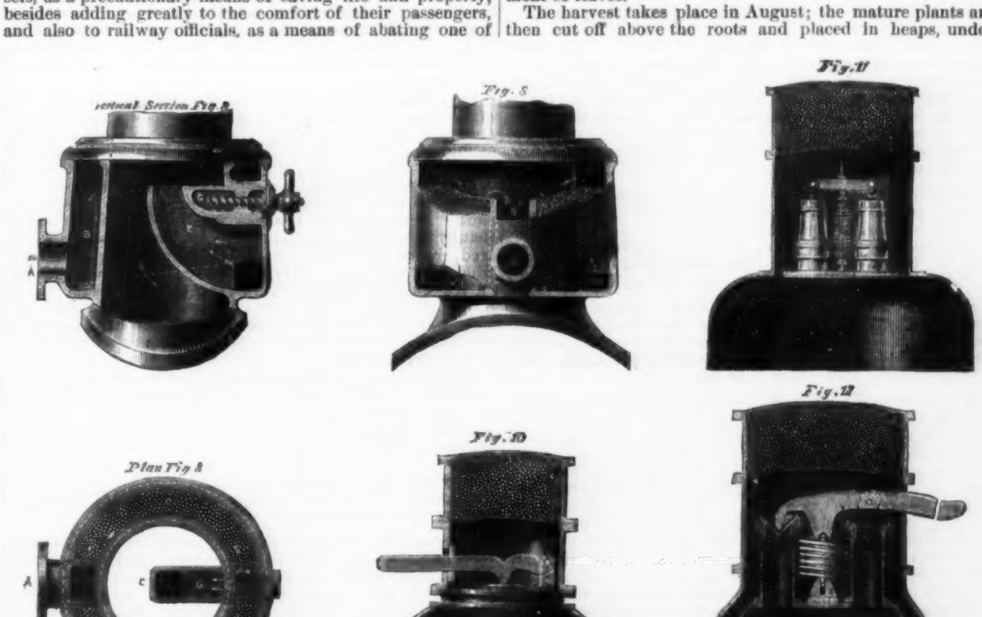
THE STEAM QUIETER.

In this busy age of steam, and the noisy tumult produced by its commercial utilization, it may be well questioned if the average duration of human life is not somewhat lessened by the almost unceasing noise and roar of escaping steam wherever we bend our steps. That our material comfort is greatly abridged by the noise of this boisterous, yet most useful of servants, steam, admits of no doubt; and it is equally true, that in times of danger or collision, as on ocean steamers, for example, it is simply impossible to communicate orders intelligently, while the hideous roaring from the safety valves not only drowns all such attempts, but tends to terrify many who in quieter moments would be guided by their reason instead of their fears. Thus, no doubt, the loss of many valuable lives and much property has been contributed to by useless noise.



We have lately witnessed an exhibition which convinces us that the usual terrific roaring of steam, escaping from safety valves at high pressures, is not a necessity, but, on the contrary, this potent agent can be thoroughly controlled and made to conduct itself in so quiet and yet so energetic a manner as to meet all the demands of its most exacting masters as regards power, without putting on the airs of a noisy, blustering bully, as it does whenever it gets a chance to "show off," or rather, we may say, to "blow off." We allude to an invention of Mr. Philip S. Justice, in the shape of a contrivance which he calls a "quieting chamber." Steam, when passed through it, not only escapes without "roaring," or, in fact, as he claims it, "quietly," but also without any appreciable back pressure, as is proved conclusively by test gauges.

We are, therefore, justified in recommending these chambers to the notice of all shipmasters employing steam vessels, as a precautionary means of saving life and property, besides adding greatly to the comfort of their passengers, and also to railway officials, as a means of abating one of the many nuisances which a complaining yet long suffering public so freely lays at their doors. We are informed that these chambers, arranged for the exhausts of locomotive engines, can be made equally effective with those now used, but without their noisy puffing or coughing. They are also applied as a means of discharging or blowing off waste steam from all kinds of boilers, so quietly as not to alarm the most nervous old lady or high spirited horse. Steam and vacuum railway brakes need no longer give notice of their persistent noisy presence when manipulated with the aid of this contrivance.



LONDON GAS.

The quantity of illuminating gas consumed in London, per head of the population, is rapidly increasing. In 1869, the quantity burned was 9,885,857,000 of cubic feet for a population of 3,158,671, or at the rate of a little more than 3,000 cubic feet per head. Last year the quantity used was 16,293,528,000 of cubic feet, or at the rate of more than 4,500 cubic feet per head, the population in the middle of 1878 being 3,577,304. In nine years the ratio has thus risen about 50 per cent. The London gas companies use 4,700 tons of coal a day. Their capital in 1869 was £7,828,844; and last year it was £12,282,514.

NOTES ON TOBACCO.

By W. K. GLOVER.*

These notes will, I trust, convey to you, in a somewhat condensed form, the history of tobacco. I have arranged them under different headings, which I thought would render them more concise.

Botanical Origin and Description.—The official tobacco plant, *Nicotiana tabacum*, belongs to the order Solanaceæ. It is an annual, growing six feet high, having alternate oblong lanceolate sessile leaves (those on the stem being semi-amplexicaul and decurrent), with dingy red funnel shaped flowers. The leaves are clothed with short hairs, which exude a viscid fluid, giving a waxy feeling when touched.

By cultivation the leaves assume various shapes, cordate, ovate, etc. It thrives in most temperate and sub-tropical countries, but succeeds better in some localities than others, *e. g.*, the United States, Virginia being the most celebrated for its growth. Cuba, Havana, and Manila are likewise known by their special growths.

Cultivation.—The method of raising the plants in America is as follows: The seeds having been sown in beds, and germinated sufficiently, are pricked out as soon as they are able to be handled, and allowed to gain five or six leaves (exclusive of the seminal leaves). They are then transplanted, during the month of May, into the fields, which have been previously much manured, as tobacco is a very exhaustive crop. The plants are placed two or three feet apart, in rows. In growing, the roots have a tendency to appear above ground, as is the case with Indian maize; the earth, therefore, is from time to time heaped round them. When nearly full grown, the tops are pinched off, to prevent development of flowers and seeds, and to promote the development of leaves.

The harvest takes place in August; the mature plants are then cut off above the roots and placed in heaps, under cover, and allowed to "sweat" for three or four days, after which they are hung in airy sheds to dry. They are then submitted to a similar process for one or two weeks, and, while slightly moist, the leaves are stripped and packed for exportation. In the above process of preparation, tobacco leaves appear to undergo a kind of fermentation, by which important chemical changes take place in their composition, one of the most evident being the formation of some new volatile principle, for the heavy narcotic odor in the dried leaves is wanting in the fresh ones. In drying, the leaves become brittle, and as thin as paper, the color varying from a bright yellow to a dark, and they lose eighty-eight per cent. of water.

It is a singular fact, but established beyond doubt by frequent experiment, that, while change of soil and climate effects little alteration in the botanical character of this plant, it makes a great difference in its chemical composition, so far, at least, as depends upon its mineral constituents. The conditions of soil and climate which favor the production of nicotine are precisely those which are unfavorable to its valued aroma. A given variety of tobacco will either be strong, with slight aroma, or highly aromatic, and weak in nicotine, according to the soil and climate in which the plant is grown.

* Read at an evening meeting of the Chemists' Assistants' Association, London, April 9, 1879.

The whole course of rearing and curing tobacco is a system of applied science, and one in which the planter has to use incessant watchfulness; the slightest error in drying, in time and extent of fermentation, etc., may spoil a whole crop. The cultivation of tobacco has been prohibited in England since 1652, not more than half a pole ($15\frac{1}{8}$ square yards) being allowed "in a physic or university garden, or in any private garden for physic or chirurgery." This act did not extend to Ireland, and, previous to the year 1830, it was grown there to a considerable extent.

History.—It is supposed to have been known from time immemorial to the inhabitants of Centrai and South America, and was unknown in the Old World before the discovery of that continent. It is said to have been discovered by the Spaniards in 1492, when Columbus and his companions landed at Cuba and saw the inhabitants smoking cigars. Another writer states that the Spaniards discovered it at Yucatan in 1520, when it was called "petun" or "petum." It was sent by them from Tabaco, or Tabasco, a Mexican province, to Spain, hence its name. Humboldt asserts that it derives its name from the Haytian word "Tabaco," for the pipe in which the herb is smoked, and which has been transferred from the instrument to the plant. There is no doubt that the tobacco is a native of some part of South or Central America, but the precise country of its origin cannot now be determined.

The genus Nicotiana derives its name from the French ambassador, Jean Nicot, at Lisbon, who was the means of introducing the tobacco plant into France about 1560. In the reign of Henry III. of France it was called "l'herbe à la reine," in honor of Catharine de Medicis. The Rue Jean Nicot, in Paris, running in front of the Manufacture de Tabac, is named after the ambassador. Its introduction into England was made, in 1586, by Sir Francis Blake, from Virginia, where an English colony had remained for a year. The colonists are said to have brought tobacco with them on their return, and to have introduced into this country the practice of tobacco smoking, or, as it was first called, tobacco drinking, the first methods of imbibing the fumes being by means of a walnut shell and a straw. Sir Walter Raleigh and other young men of fashion gave it every encouragement by smoking themselves, and the habit was soon acquired by the English, as it had previously been by the Spaniards.

The practice of smoking since that period has become by degrees almost universal among nations, despite the efforts of their rulers at prohibition. The priests and sultans of Turkey declared smoking to be a sin against their holy religion, yet the Turks and Persians became the greatest smokers in the world. In Russia, the smoker was threatened with the knout for the first offense, and with death for the second, yet the Russians are now constantly with pipes in their mouths. In our own country James I. wrote a book against it, entitled "Counter-blast to Tobacco," but, instead of checking, it rather tended to promote the spread of the habit among his subjects. Finding no penalties, however severe, could check indulgence in this luxury, sovereigns and their governments soon found it much more advantageous to turn it into a source of revenue, and the cultivation and manufacture of tobacco were gradually subjected almost everywhere to fiscal regulations, restrictions, or monopolies, which still prevail in various forms over the greater part of Europe.

During the early part of the reign of Charles I. the trade was monopolized by the Crown. This monopoly was not of long duration, and totally ceased at the breaking out of the Civil Wars. In France, Spain, and Austria, and other countries the trade is still in the hands of the government. The duty in foreign countries on manufactured tobacco never exceeds 3d. per lb., and in Belgium it is only a $\frac{1}{4}$d., while in England it is 3s. 6d.

Consumption.—It has been recently estimated that the average in this country is about $1\frac{1}{2}$ lb. per head, in Germany, 6 lbs., and in Holland more money is said to be spent in tobacco than bread. According to the *Statistical Journal*, 1872, the quantity of tobacco consumed by two generations of Britons was 1,280,094 tons, of the value of £578,039,841.

Revenue.—The revenue derived from tobacco duty last year was £8,750,000, or one-tenth of the whole revenue of this country. The duty paid by manufacturers ranges from 5 to 30 guineas, according to the quantity produced. The regular dealer's license duty is 5s. 3d.

Manufacture, etc.—A visit to the tobacco warehouse, Victoria Docks (a building of vast dimensions, having no less than 15 acres of floorage), will at once give you an idea as to what extent tobacco is used. Over 20,000 hogsheads, each holding about 1,200 lbs., may be seen waiting buyers, besides packages and bales, weighing in all between 17,000 and 18,000 tons. When a case is opened, the whole of the covering is removed, so that the purchaser may see if the contents are in any way damaged by bad packing, sea water, etc., when, if such be the case, the part deteriorated is cut off by the custom-house officers, as no tobacco of any description is allowed to be removed till the full duty has been paid, the waste, which is sometimes very large, being consigned, with the sweepings of the warehouses and impounded smuggled tobacco, to the "Queen's Pipe," a kiln built for the purpose.

The process of manufacture is as follows:

The leaves, which are generally imported in "hands," that is, several leaves being tied together at their bases, are carefully separated, after being moistened. Some leaves take up larger quantities of water than others; the poorer the leaf, such as Java, the more absorbent (36 per cent.); the richer the leaf, such as Virginia, the smaller the quantity (12 per cent.). In this country water alone is allowed by the excise. It is generally boiling when applied. The leaves are then heaped together, and allowed to undergo a slight amount of fermentation. On the continent, the addition of certain salts and sugar is allowed. The liquid, when prepared, is called "sauce."

The process of cutting is accomplished in a machine somewhat resembling a chaff cutter, the leaves being introduced through a trough between rollers, by which it is very firmly compressed. The knives, working in unison with the rollers, make about 300 cuts a minute, turning out about 200 lbs. of bird's eye an hour. For *shag*, the greater part of the midrib is removed, and is generally sent over in that state, thus saving the duty on the less valuable and heavier midribs. The tobacco, when cut, is then dried in troughs heated by gas, or sometimes first heated by steam while suspended in a cloth stretched across the bath, and afterward dried. This process takes the cut out of it, and allows it to be more easily worked into shape for sale.

It is constantly turned while drying, and is finished off by being placed on wooden trays exposed to the air for a few hours. The light colored tobaccos are all more or less doctored and flavored, essence of vanilla, oil of cassia, olive oil, glycerine, acetic acid, etc., being used to further these ends.

Cavendish is prepared by the following process: The darkest leaves are selected, moistened, and allowed to sweat, which renders them of a darker tint; they are then carefully smoothed out, and packed over one another in small bundles, and hydraulic pressure applied for a considerable time, varying from a fortnight to three weeks, which causes the juice of the leaf to exude to some extent, rendering the whole mass of a black color. No other addition but water is allowed, but that of foreign manufacture is sweetened with molasses. Cut cavendish is darker than the cake, from its having gone through steaming process, which all cut tobaccos do.

Roll Tobacco.—This variety bears several names, according to the thickness and quality of the roll. It consists generally of an inferior leaf. The process is as follows:

The leaves, after being well damped, are cut in half, and the midrib removed. A leaf is then twisted round a spindle which is kept revolving. The workman, who has a small board strapped on his hand, applies leaf after leaf, pressing at the same time with the piece of board to render the twist regular in thickness. When finished, it is coiled up in a stick, the end secured, and pressure applied, which reduces it considerably in bulk, and darkens the color from a light brown to almost a black. They are sometimes dipped in a sauce composed of the expressed juice and molasses, to give a finishing coat.

Cigars are only the dried leaves deprived of their midribs and wound into a spindle form. They are made with the moist leaf, which, in some cases, is treated with various flavorings, and in cheap cigars the interior consists of inferior leaf cuttings and scraps, which are finally enveloped in a selected leaf, which sometimes has a slight splash of tincture of iron applied to give it certain marks which connoisseurs consider a test for a good cigar. Many cigars, purporting to be true Havanas, are composed mainly of German or other continental tobacco, which is shipped to Havana, and manufactured there into cigars, receiving as an external coat a true Havana leaf. They are then imported into this country, as above stated. Cigar making gives employment to a very large number of hands in London, and it has been stated that the British cigar maker can turn out cigars in no way inferior to foreign make. The process is one of great dexterity, and a good hand earns between £3 and £4 a week.

Snuff is tobacco finely ground, and is generally made from the refuse, or "smalts," and the midribs which are rejected in the manufacture of shag. Its manufacture is confined to a few large mills. The process consists of cutting the midribs into a kind of chaff, and heaping them together in a moist state; when sufficiently heated by the fermentation set up (which is known by the interior becoming almost black), it is then slightly dried and ground between stones, and from that passed through a tube or gutter, by means of an endless screw, to a series of large fluted iron mortars, whose jointed pestles are kept revolving by a shaft to which they are attached. This finishes the process of grinding. It is rather an interesting and novel sight to see the partially ground snuff traveling along like a stream of water to its destination as above. The same method is made use of in large agricultural works for conveying the crushed bones to their separate bins.

In preparing some snuffs the fermenting process is not gone through, but they are either roasted in cylinders, or merely ground after drying. Snuff, whether moist or dried, should consist of nothing but the tobacco leaves, with or without the midribs, but oil, lime water, etc., starches of the cereals, pea meal, bran, sawdust, fustic, oxide of iron, and ground glass have at various times been used to adulterate snuff. A shoemaker's foreman was once heard to assert that by careful study and analysis he had at length discovered the principal ingredients of snuff. "Ay, mon, an' what's it made o'?" "Oh, just wi' coffee an' grun glaiss, an' it's the glaiss ticklin' yer nizz that gars ye sneeze." I do not think adulteration is carried on quite to that extent, but a few years ago, in Ireland, the Valonia acorn cups, imported for tanning purposes, were extensively used as an adulterant to high dried snuff.

On examining an adulterant sample with the microscope, it will be found to present a similar structure peculiar to our fruit stones, and, like them, contain an abundance of very thick walled porous cells, lying scattered or in masses among cellular tissue. No such cells as these exist anywhere in the tobacco leaf or plant, and they are so characteristic, as to proclaim at once their nature, if not their exact origin. The hairs of Valonia acorn cup are simple hollow filaments, and are somewhat branched.

Tobacco Leaf Adulterations.—The temptation to adulterate tobacco in its various forms is very great, and will ever remain so while the tax on importation bears such an enormous ratio to the taxed material as that of 3s. 6d. per lb. on leaves varying in price from 1d. to 3s. 6d. per lb. It might be safely said that not one person in a hundred has the slightest acquaintance with the general features and character of tobacco; and until the last few years it was found that leaves of wayside plants crept into the cigar and cut tobacco, but by comparing these leaves with those of tobacco under the microscope, they will be found to possess certain unchangeable characters peculiar to each.

I will cite a few examples: A section of the midrib of a tobacco leaf (as is seen in bird's-eye) presents a horseshoe form, in which the woody tissue lies as a central mass, surrounded by the cellular tissue. In all the leaves with which tobacco is, or is likely to be, adulterated, the woody tissue of their midribs, or stalks, lies in separate detached bundles. By using a higher power with the microscope, we shall find that the minute hairs with which each leaf is furnished have definite characters, and form invaluable evidence as to their source, and, from their extreme delicacy of formation, they elude the grinding action of the snuff mill.

The tobacco leaf is furnished with two forms of hairs, long and short. The former consist of three or four elongated cells, joined end to end, and finally surmounted by a cluster of minute cells forming a gland, which contains a rich brown coloring matter. These are called glandular hairs, and they have two or more cells forming a compound base. The short hairs are unicellular, with a cluster of cells at the apex also containing coloring matter; their bases are simple.

The leaves of the *Dock* are furnished with peculiar club shaped unicellular hairs, free from coloring matter, but the surface is striated, formed by a wrinkling, as it were, of the cell walls. An equally marked character is the presence of numerous glands containing raphides of oxalate of calcium; these are found on the thin portion of the leaf blade, the hairs being principally on the veins and midribs.

Leaves of the *Burdock*. These are covered on their lower surface with a dense greenish white woolly substance, which consists of a number of hairs, each composed of a number of cubical cells joined together like a string of beads. These gradually diminish in size, and finally end in a slender transparent filament of great length. The bases of these hairs are compound.

Leaves of the *Chiccory*. These have a special call for our attention. A few years ago some tons of these leaves, steeped in tar oil, were seized in Ireland by the revenue officers on the premises of a cigar manufacturer, by whom they had been freely used as "fillers" for "pure Havanas," and so good was the sophistication, that many practical men were actually deceived by them. When the leaves were unrolled, their margins at once told a tale, and when examined under a high power lens, abundant minute hairs were discovered, as unlike those on the tobacco leaf as could well be imagined. For above a third of its length each hair is composed of a number of oblong cells laid side by side and end to end; these gradually lessen in number, until they form a row of single cells joined together. A cluster of cells form a compound base to each hair.

The leaf of the *Comfrey*. This leaf is farnished with two forms of hairs, both of them very singular in appearance. They are both unicellular, the smaller one being formed like a fishhook, the other very sharp pointed, with a compound base, and the whole surface coarsely striated.

The leaf of the *Jerusalem Artichoke* furnishes beautiful examples of compound hairs with recurved points and compound bases, their surfaces being covered with minute warts.

There are several other leaves which have at times been used, but it would occupy too much time to mention more. The margins of the leaves are no sure test, as they are in most cases trimmed off before making up into cigars.

Its Application in Medicine.—Tobacco has been recommended in the form of an ointment in croup, as a cataplasm for articular rheumatism, as well as for injection in obstinate vermicose affections. As a narcotic, it is employed chiefly to produce relaxation in spasmodic affections. For this purpose the infusion, or the leaf in substance, in the shape of a suppository, is introduced into the rectum in cases of strangulated hernia and obstinate constipation from spasm of the bowel. Snuff drawn up the nose is said to be an effectual remedy for maggots in the nose (*Medical Times and Gazette*, February, 1875). The internal use of tobacco is seldom resorted to, from the distressing nausea it is apt to occasion.

Chemical Composition.—Tobacco contains an extremely poisonous substance, called nicotine, to the extent sometimes of six per cent., but the proportion is liable to great variation. It can be extracted from a watery or alcoholic extract of the leaves as a malate, from which the alkaloid may be obtained by mixing with solution of potash, which sets free the nicotine; this is again taken up on agitating with ether, which is then drawn off; a little slaked lime is then added, and distilled in a current of hydrogen, the temperature being gradually raised by means of an oil bath to 356° Fahr., at which the nicotine is volatile. It is a colorless, oily liquid, sp. gr. 1·027, with a strong alkaline reaction. It is very soluble in water, spirit, ether, turpentine, and the fatty oils; it boils and undergoes decomposition at 482° Fahr.

It is a very active poison, resembling hydrocyanic acid in its action, and was employed by Count Bocarmé for the murder of his brother-in-law some years ago. The only other substance of any importance in tobacco is "nicotianin," or "tobacco camphor," which is obtained by distilling the leaves with water. It is a concrete volatile oil, and is only present in small quantities, about two grains in each pound. It is not poisonous. Both the above substances are said to be present in the impure oil resulting from the combustion of tobacco. This empyreumatic oil is said to have been used by the Hottentots to kill snakes, which is done by placing the pipe stem on the reptile's tongue, producing sudden death as by an electric shock. This oil is officinal in the United States Pharmacopœia, and is obtained by destructive distillation.

It is a thickish black liquid of a strong characteristic odor, identical with that of old tobacco pipes. It is a powerful poison, and is used in the form of an ointment—twenty drops to the ounce—as an application to indolent ulcers, but it requires great caution when the skin is abraided. The composition of tobacco smoke has not been thoroughly settled, but recent researches have rendered it at least very probable that it owes very little of its potency to nicotine, and very much to the combustion products, of which pyridin seems to be the most powerful. These products seem to differ from nicotine in their action only by being milder and less toxic in their operation.

The tobacco leaf is among the leaves which are richest in mineral matter, yielding 19 to 28 per cent. It is this which forms the ashes to our pipes and the nozzets of our burning cigars. This fact alone shows to what an extent the plant draws upon the soil.

Its Use and Abuse.—From the earliest ages narcotics have been used in various forms by the human race, and to this practice among the heathen Isaiah probably alludes when he upbraids the Jews for "remaining in the groves and lodging in the monuments," for at that time it is well known that men went into the heathen temples to place themselves under the influence of some narcotic, presumably opium. And so with other races.

In the south of Asia the betel leaf, with areca nut and a little "chunnum" (lime produced from burning shells), is said to act on the nervous system by soothing, and at the same time promoting digestion. The latter action is open to doubt. The coca leaf has likewise been much vaunted, but in this country has not proved so valuable as it is said to be in Peru, where the miners use it regularly, chewing it with lime.

Tobacco is one, and one of the least harmful, of those agents by which soldiers and others who are compelled to undergo strenuous exertions at times, with a sadly insufficient supply of food, are enabled to hold out and do their work effectively. What opium is to the Tartar courier, or coca leaf to the Peruvian miner, tobacco is to the British soldier and sailor, in supporting him under severe and continuous efforts, when rest and sufficient food are alike beyond his reach. But the pernicious habit of smoking at any and at every time, as is practiced in the present day by persons in full health, is a useless, dirty, and an expensive one, and is too often injurious, in an indirect manner, by its acting as an inducement to drink.

It is true that the more the wants of man are multiplied,

the more industrious he becomes; but the use of tobacco is at once a dirty and an offensive luxury, and, with the exception of ardent spirits, there is hardly any article in which the money of the poor would not be better expended. There can, I think, be no doubt that the habit of smoking is spread more from the force of example than from any beneficial results produced by it. As regards the physiological action of tobacco upon the bulk of mankind, and apart from its moral influences, it may be received, as characteristics of this substance among narcotics:

1st. That its greater and first effects are to assuage and allay and soothe the system in general with a temporary annihilation of thought.

2d. That its lesser and second or after effects are to excite and invigorate, and at the same time to give steadiness and fixity to the powers of thought.

The most familiar of the physiological effects of tobacco are those experienced by young smokers, who rarely fail to poison themselves to a greater or less extent, nausea, giddiness, cold sweating, and vomiting being the symptoms in their first trials. According to a celebrated writer, speaking on the effects of smoking, he states that he has repeatedly asked the Turks what they had been thinking about while smoking? The answer was, "Of nothing." Not a single idea could be recalled to their minds. This may be a peculiarity of the Turkish or Moslem character, but I have heard fellow-students remark that they could do no real study while smoking. However, it is a known fact that some German writers invariably smoke while writing. If it is so conducive to health, why should it be so exclusively enjoyed by the male sex?

I will conclude with an extract from the "Counter-blast to Tobacco:" "Have you not reason, then, to be ashamed and to forbear this filthy novelty, so basely grounded, so foolishly received, and so grossly mistaken in the right use thereof? A custom loathsome to the eye, hateful to the nose, harmful to the brain, dangerous to the lungs, and in black stinking fume thereof nearest resembling the horrible Stygian smoke of the pit which is bottomless."

ARTIFICIAL FRUIT ESSENCES.

PROFESSOR MAISCH has recently compiled the following particulars respecting the preparation of artificial fruit essences:

Fourteen years ago Kletzinsky published formulæ for fifteen different fruit essences, which, in 1867, were republished by several journals. Several of these formulæ were again produced in the last volume of the *Confectioners' Journal* without any alterations, except that in the essence of apple, the quantity of oxalic acid was reduced from 1 to ½ part, and glycerine from 4 to 2 parts; in essence of raspberry, the succinic acid was entirely omitted, and essence of peach was directed to be made of 2 oz. of oil of bitter almonds, 1 oz. of acetic ether, and 2 pints of alcohol, but the latter product has evidently the flavor of peach kernels accompanied by a slight fruit odor. The flavor of peach fruit may be imitated by using 5 parts each of acetic, butyric and amyl-acetic ethers, ⅛ part (or less) of methyl-salicylic ether (oil of wintergreen), 2 or 3 parts of oil of bitter almonds, and 80 or 100 parts of alcohol.

Kletzinsky's formulæ for the extracts of strawberry and raspberry are much improved by adding from 20 to 10 per cent. of tincture of orris root. If desired, the rather acid taste of this tincture may be removed by precipitating the resin, and if solution of acetate of lead is used for this purpose, the filtrate should be carefully freed from any excess of lead by sulphureted hydrogen, or by agitation with solution of sulphate of sodium, which salt, being insoluble in the alcoholic liquid, will not impart to it its peculiar saline taste. The tincture of orris may probably be conveniently replaced by an alcoholic solution of the oil of orris, which has been an article of commerce for some years past.

Since several very important errors had crept into the formulæ of Kletzinsky as published in 1867, some of which are, however, readily corrected, it has been thought best to republish all the formulæ from Wittstein's *Vierteljahrsschrift*, xvi., p. 268.

These formulæ are given in *parts by measure for* 100 *parts of alcohol*, and whenever acids are used they are to be previously dissolved in alcohol.

Essence of Apple.—Aldehyd, 2 parts; chloroform, acetic ether, nitrous ether, and oxalic acid, each 1 part; glycerine, 4 parts; amyl-valerianic ether, 10 parts.

Essence of Pear.—Acetic ether, 5 parts; amyl-acetic ether and glycerine, each 2 parts.

Essence of Cherry.—Benzoic ether, acetic ether, each 5 parts; glycerine, 3 parts; œnanthic ether and benzoic acid, each 1 part.

Essence of Black Cherry.—Benzoic ether, 5 parts; acetic ether, 10 parts; oil of persico (peach kernels) and benzoic acid, each 2 parts; oxalic acid, 1 part.

Essence of Peach.—Formic ether, valerianic ether, butyric ether, acetic ether, glycerine, and oil of persico, each 5 parts; aldehyd and amylic alcohol, each 2 parts; sebacylic ether, 1 part.

Essence of Apricot.—Butyric ether, 10 parts; valerianic ether, 5 parts; glycerine, 4 parts; amylic alcohol, 2 parts; amyl-butyric ether, chloroform, œnanthic ether, and tartaric acid, each 1 part.

Essence of Plums.—Glycerine, 8 parts; acetic ether and aldehyd, each 5 parts; oil of persico, 4 parts; butyric ether, 2 parts; and formic ether, 1 part.

Essence of Grape.—Œnanthic ether, glycerine, each 10 parts; tartaric acid, 5 parts; succinic acid, 3 parts; aldehyd, chloroform, and formic ether, each 2 parts; and methyl-salicylic ether, 1 part.

Essence of Currant.—Acetic ether, tartaric acid, each 5 parts; benzoic acid, succinic acid, benzoic ether, aldehyd, and œnanthic acid, each 1 part.

Essence of Strawberry.—Butyric ether and acetic ether, each 5 parts; amyl-acetic ether, 3 parts; amyl butyric ether and glycerine, each 2 parts; formic ether, nitrous ether, and methyl-salicylic ether, each 1 part.

Essence of Raspberry.—Acetic ether and tartaric acid, each 5 parts; glycerine, 4 parts; aldehyd, formic ether, benzoic ether, butyric ether, amyl-butyric ether, acetic ether, œnanthic ether, methyl-salicylic ether, nitrous ether, sebacylic ether, and succinic acid, each 1 part.

Essence of Pineapple.—Amyl-butyric ether, 10 parts; butyric ether, 5 parts; glycerine, 3 parts; aldehyd and chloroform, each 1 part.

Essence of Melon.—Sebacylic ether, 10 parts; valerianic ether, 5 parts; glycerine, 3 parts; butyric ether, 4 parts; aldehyd, 2 parts; formic ether, 1 part.

Essence of Orange.—Oil of orange and glycerine, each 10 parts; aldehyd and chloroform, each 2 parts; acetic ether, 5 parts; benzoic ether, formic ether, butyric ether, amyl-acetic ether, methyl-salicylic ether, and tartaric acid, each 1 part.

Essence of Lemon.—Oil of lemon, acetic ether, and tartaric acid, each 10 parts; glycerine, 5 parts; aldehyd, 2 parts; chloroform, nitrous ether, and succinic acid, each 1 part.

The different manufacturers of artificial fruit essences doubtless prepare them by formulæ of their own, and this explains the difference in the flavor, which is particularly noticeable on largely diluting them with water. If the essences have been prepared with a dilute alcohol, their odor is more prominent, and they are apparently stronger; but on mixing a small quantity with a large quantity of water in given proportions, the true flavoring strength may be better discerned.

A fruit essence which is much employed in the United States is *essence of banana;* it consists usually of butyric ether and amyl-acetic ether, equal parts, dissolved in about 5 parts of alcohol.

The red color of strawberry and raspberry essence is produced by aniline red (fuchsin), the bluish tint of which is conveniently neutralized by a little caramel. If caramel alone is used for coloring essences a yellow or brown color is obtained, according to the quantity used.

The *Confectioners' Journal* gives formulæ, also, for the following essences:

Essence of Blackberry.—Tincture of orris root (1 to 8), 1 pint; acetic ether, 30 drops; butyric ether, 60 drops.

Essence of Nectarine.—Extract of vanilla, 2 parts; essence of lemon, 2 parts; essence of pineapple, 1 part.

JELLIES, JAMS, AND PRESERVES.

Apple Jelly.—Take some of the sourest apples obtainable, and after rinsing them in water, cut them into quarters; place them in a brass kettle, add enough water to cover them, and boil them until tender and soft; then strain through a wicker sieve. Fill the sieve with boiled apples, allow them to drain six to eight hours, put the juice into a boiler, bring it to the boiling point, and strain through a flannel bag. To every gallon of this filtered juice add 6 lb. white sugar, and boil over a sharp fire to the jelly degree, removing scum with a filter. To determine the proper degree, let a drop or two from the skimmer fall into a glass of cold water; if it reaches the bottom of the tumbler without dissolving in the water, a solid drop of jelly, remove from the fire at once, and fill into dry and heated glasses.

Crab Apple Jelly.—Cut Siberian crab apples to pieces, but do not pare or remove the seeds, as the latter impart a peculiarly pleasant flavor to the jelly. Put the fruit into a stone jar, set in a pot of hot water, and let boil 8 or 10 hours. Let it stand in jar over night covered closely. Next morning squeeze out the juice; allow a pound of sugar to every pint of juice, and proceed as above. Should the apples be very dry a gill of water may be added for every 6 lb.

Quince Jelly.—Pare and slice the quinces, and add ½ pt. water to every 3 lb. fruit. Put the peelings, cores, and all, into a stone jar; set this in a pot of boiling water, and when the fruit is soft and broken, proceed as above, allowing 6 lb. sugar to every gallon of juice.

Raspberry Jelly.—To 50 lb. raspberries take 20 lb. white or red currants. Press the juice from them, heat on the fire, strain through a flannel, and proceed as above.

White Currant Jelly.—As raspberry jelly; allow, however, 9 lb. sugar to a gallon juice.

Peach Jelly.—Pare and stew the peaches, boiling in the same manner as apple jelly. For every 40 lb. stewed peaches allow 10 lb. sour apples; boil the latter in soft water, extract their juice, and add to the peach juice. Proceed as with apple jelly.

Red Currant Jelly.—Take red currants fully ripe, put them into a preserving pan, mash them up, and place them on the fire to get scalding hot, stirring them all the time with a wooden spatula; remove from the fire, and when cold enough, strain them through a coarse crash towel till all the juice has been extracted. Measure the juice into a clean copper or porcelain pan, place it upon the fire and let it boil five minutes; then add 1 lb. pulverized sugar to every pint juice; stir constantly from the bottom while adding the sugar, and continue to do so until the sugar is completely dissolved; then remove scum and fill jelly glasses immediately, which must be all ready, as the jelly forms very quickly.

Cherry Jelly.—Stone and stew a quantity of the best cherries. To every 2 lb. cherries add 1 lb. red currants. Put them into a copper preserving pan, place over the fire, and reduce to a mash, stirring with a wooden spatula. Then strain through a hair sieve, and filter through a jelly bag. To each pound fruit add ¾ lb. sugar, place again on the fire and boil to a jelly. When cold cover the tops with brandied paper. Tie up.

Gooseberry Jelly.—Take full grown, but not quite ripe berries, cover them with water, and boil till they commence to fall to pieces, and are fully soft. Drain off and strain the juice. To every gallon of juice add 4 lb. sugar, and boil to the jelly degree.

General Notes.—Whenever a sweet fruit is used in making jellies, such as pears, etc., add some very sour apple juice, say about half; for strawberries use red currant juice. By themselves, you cannot boil these sweet fruits to a jelly degree, as they lack acid, the principle that causes jelly to harden into a body.

In making jellies nothing should be wasted; the pulp can be put up as marmalade for tarts and cake fillings.

Care must be taken to boil jelly neither too long nor too short a time; to boil any fruit jelly too long will make it tough, discolor, and injure its flavor; insufficient boiling will prevent them from keeping.

To get a good preserve or jelly, it is necessary to have the fruit freshly gathered; and whatever has been boiled, never let it remain over night, but use and finish up the same day all you have commenced.

Never use tin vessels in boiling fruits, especially red fruits; the acid of the fruit coming in contact with the tin produces a poisonous agent. Use copper or brass kettles, or brass lined with porcelain. No fruit should be allowed to remain in the former longer than is necessary to boil them. Never use wire sieves or iron pots, as they destroy the flavor, and always stir the fruit with either a wooden or silver spoon.

Jellies and preserves should be carefully tied over, when cooled, with either bladder or parchment paper; before tying on, however, place on a piece of paper, dipped in salad oil or alcohol. If jellies are put up in wine bottles for exportation, put about a tablespoonful of alcohol into each bottle before sealing.

MARMALADES AND JAMS.

These are the pulp of fruits reduced to a consistence with sugar by being boiled. All acid fruits should have their full quantity of sugar, and others a little less. If they contain too much sugar they are apt to crystallize, or candy; the tops and sides of the vessels which contain them will be covered with a coating of sugar; and if there is not enough in it, or if it is not sufficiently boiled or evaporated, it will soon ferment. They should be kept in a cool dry place.

Peach Marmalade.—Pare and stone fine, ripe peaches, put them in a preserving pan with a little water, place the pan on the fire, reduce them to a pulp, and pass them through a colander. To each pound pulp add ¾ lb. pulverized sugar; put this on the fire and boil until it will jelly, or until it is sufficiently evaporated to drop from the spatula in clots. Be careful to stir it with a wooden spatula from the bottom of the pan all the time it is on the fire. When done, put into pots; and when cold, cover over with paper dipped in brandy. *Quinces, apples, pears, apricots,* and *other fruits* may be prepared as above.

Raspberry Marmalade.—¾ lb. sugar to every pound of fruit. Put the fruit in alone, or with the addition of 1 pt. red currant juice to every 4 lb. fruit. Boil ½ hour, mashing and stirring well. Add the sugar and cook 20 minutes more.

Blackberry Marmalade.—As above, omitting currant juice.

Quince Marmalade.—Pare, core, and slice the quinces, stewing skins, cores, and seeds in a vessel by themselves, with just enough water to cover them. When this has simmered long enough to extract all the flavor, and the parings are broken to pieces, strain off the water through a thick cloth. Put the quinces into the preserving kettle when this water is almost cold, pour it over them and boil, stirring and mashing the fruit with a wooden spoon as it becomes soft. The juice of two oranges to every three pounds fruit imparts an agreeable flavor. When you have reduced all to a smooth paste stir in ¾ lb. sugar for every pound fruit; boil ten minutes more, stirring constantly. Take off, and when cool, put into small jars with brandied paper over them.

Quince Cheese is marmalade boiled down *very* thick, packed into small pots. It will turn out firm as cheese, and can be cut in slices for luncheon or tea.

Rhubarb and Orange Marmalade.—Take 1 dozen oranges, pare off the yellow peel, discarding the thick, white rind and seeds; cut the peel into small pieces and put it with the sliced pulp; add 2 qt. sliced rhubarb and 3 lb. granulated sugar. Boil the whole slowly until quite thick. When cool turn into cups and cover with paper, varnished over with the whites of eggs, and pasted to the cup.

Strawberry Marmalade or Jam.—To 12 lb. strawberries add 2 lb. ripe currants, and 10 lb. sugar. Mash the currants with ½ pt. water in preserving pan. Place over the fire and allow to boil. Add the picked strawberries; rub and press both through a hair sieve into an earthenware pan; boil the sugar to the consistency of thick molasses; add the pulped fruit; place over a brisk fire for twenty minutes, stirring constantly. Skim the jam and pour into earthen pots. When cold cover tightly with oiled paper.

PRESERVES.

Quinces.—Pare, quarter, and core fine, yellow quinces, saving both skins and cores. Put the quinces over the fire, with just enough water to cover them, and simmer until they are soft, but not until they begin to break. Take them out carefully and spread upon bread dishes to cool. Add the parings, seeds, and cores to the water in which the quinces were boiled, and stew, closely covered, for an hour. Strain through a jelly bag, and to every pint of this liquor add 1 lb. sugar. Boil up and skim; put in the fruit, and boil 25 minutes. Take all from the fire and pour into a large deep pan. Cover closely and let stand 24 hours. Drain off the sirup and let it come to a boil, put in the quinces carefully and boil another quarter hour. Take them up as dry as possible and spread them out upon dishes again, setting them in the hot sunshine. Boil the sirup until it begins to jelly, fill the jars ⅔ full, and cover with the sirup. The preserves should be a fine red color. Cover with brandied tissue paper.

Apples.—Select firm, well-flavored pippins, or bell flowers, and proceed as above. A few quinces cut up among them, or the juice of 2 lemons to every 3 lb. fruit, improves them.

Crab Apples.—The red Siberian crab is the best. Pick out those nearly perfect, *leaving the stems on;* put them in a preserving kettle with enough warm water to cover them, heat this to boiling, slowly, and simmer until the skins break. Drain and skin them; then with a penknife extract the cores through the blossom ends. Weigh them; allow 1½ lb. sugar and a gill of water to every pound fruit. Boil the water and sugar together until the scum ceases to rise, put in the fruit, cover the kettle, and simmer until the apples are a clear red and tender. Take out with a skimmer, spread upon dishes to cool and harden; add to the sirup the juice of one lemon to 3 lb. fruit, and boil until clear and rich. Fill jars ¾ full with apples, pour in the sirup, and, when cool, tie up.

Muskmelon.—Take ripe muskmelons, remove seeds, peel, and cut in pieces. Put into a stone jar and cover with scalding vinegar; let them stand until the next day, and pour off the vinegar, heat it and pour on them again; repeat this every day until the fourth day. Weigh the melons, and to every 5 lb. fruit add 3 lb. white sugar, 1 qt. vinegar, and spices to suit. Put all together and simmer until tender. The next day but one pour off the sirup, and boil it down, so there will be just enough to cover the melons.

Cherries.—Stone the cherries, preserving every drop of juice, weigh them, and allow 1 lb. sugar to every pound fruit. Put a layer of fruit for one of sugar until all is used up, pour over the juice and boil gently until the sirup begins to thicken. The short-stemmed, red cherries, or the Morellas, are the best for preserving. Sweet cherries will not do.

Orange Peel.—Weigh the oranges whole, allowing 1 lb.

sugar for 1 lb. fruit. Peel the oranges neatly, and cut the rind into narrow shreds. Boil until tender, changing the water twice, and replenishing with hot from the kettle. Squeeze the *strained* juice of the oranges over the sugar, let this heat to a boil, put in the seeds, and boil 20 minutes.

Lemon Peel.—As above, allowing, however, 1½ lb. or 2 lb. sugar to 1 lb. fruit.

Pineapples.—Slice and clean the fruit, weigh them, allowing 1 lb. pulverized sugar to every pound of slices; lay them in alternate layers of slices and sugar. Stone crocks and jars are the best for this fruit. Put the filled crocks in a warm place, let them stand for several days, shaking occasionally. When all this fine sugar has been converted into liquid, they can be closed up and stored away in a cool place.—*Western Confectioner.*

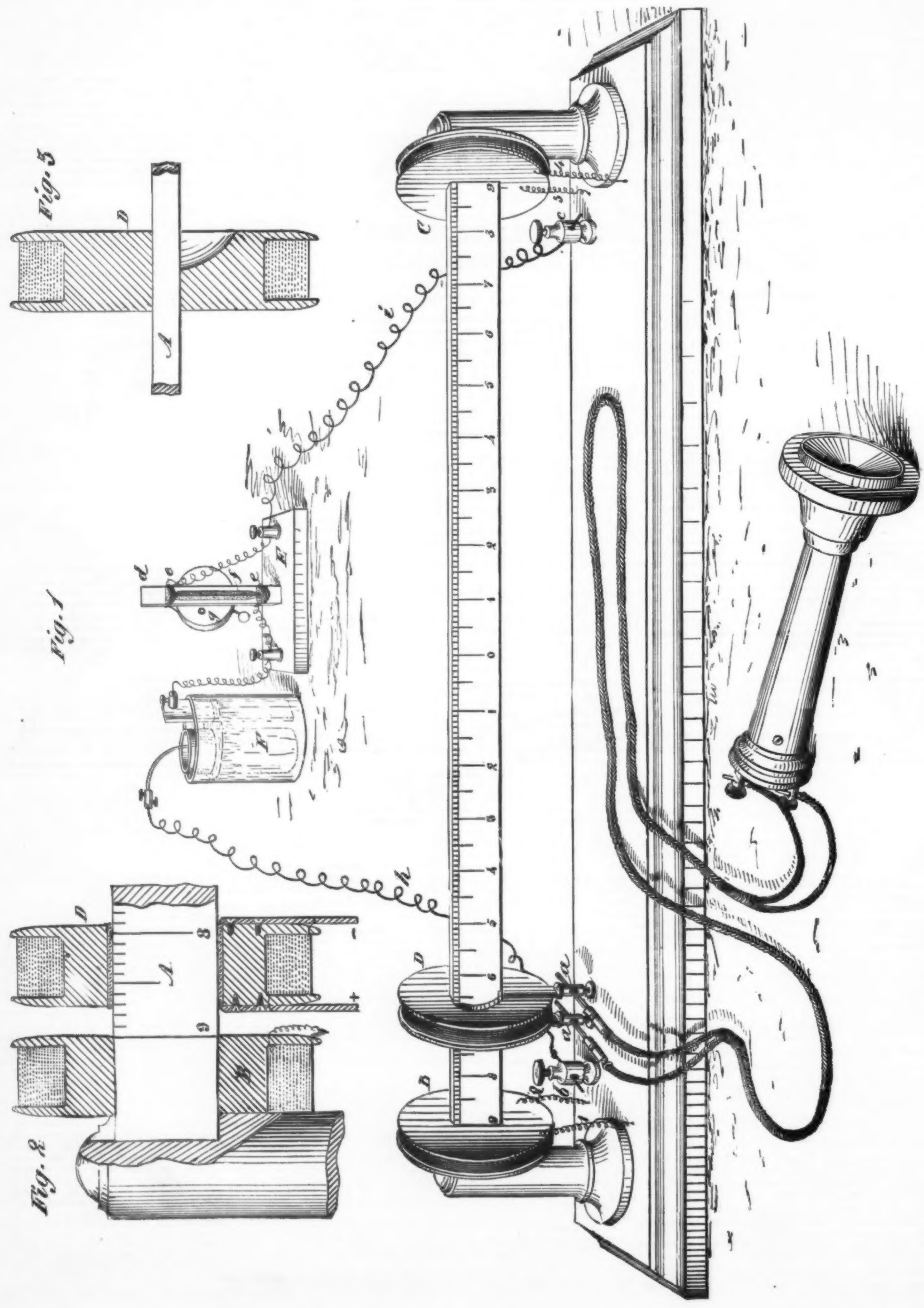
THE INDUCTION BALANCE AND SONOMETER.

By Geo. M. Hopkins.

In the whole range of recent electrical development there is perhaps nothing more deeply interesting than the instrument devised by Professor Hughes, and called indifferently the sonometer or audiometer.

The readers of the Scientific American and Supplement are already informed as to the performances of this simple yet wonderful apparatus; therefore these will be mentioned only incidentally, while an attempt is made to give the points required to enable our amateurs to make the apparatus for themselves.

The instruments consist essentially of three or four simple coils of wire and a frame for supporting them; these are used in connection with a battery, a microphone, and a clock. In the accompanying engraving the two forms of instrument are shown. The sonometer is represented in perspective and in detail in Figures 1, 2, and 3; Figure 1 being a perspective view, showing the battery, microphone, and telephone connections; Figure 2, a vertical section of two



THE SONOMETER.

of the bobbins, and Figure 3, a horizontal section of the movable bobbin.

The scale, A, is 19½ inches long between the posts, ¼ inch thick, 1 inch wide, and graduated from 0 at the center into 9 one-inch spaces at each end, which are subdivided into tenths. Upon the scale, A, are placed three mahogany or boxwood spools, B, C, D, each ¾ inch thick, 3 inches in diameter, and having a groove ⅛ inch square for the reception of the wire. 350 feet of No. 32 silk covered copper wire is wound upon each spool, and one terminal of each of the outer spools, B, C, runs through the base of the instrument, where the two are twisted and soldered together. The other terminals are connected with the binding posts, *b*, *c*. The only precaution necessary in connecting these coils is to arrange them so that when they are in the circuit a battery current will traverse them in opposite directions. Whether they are properly connected may be readily determined by holding a small box compass first above one and then above the other, while the binding posts, *b*, *c*, are connected with the poles of a battery. If the compass needle reverses its position in passing from one coil to the other, the connections are correct.

The coils, B, C, are fixed; but the coil, D, is movable upon the scale, A, and its center is cut away, as shown in Fig. 3, to permit of seeing the graduations of the scale immediately under the center of the coil. The terminals of the coil, D, are connected with binding posts, *a*, *a*, which receive the ends of the flexible telephone cord. The coils, B, C, are in a circuit which includes the battery, F, and microphone, E, the connections being made by the wires, *h*, *i*. The battery may be a single cell of Fuller, or two or three gravity or Daniell cells. The microphone is of the simplest kind, consisting of a pine box one inch deep and six inches square, having a ⅛ inch top and no bottom. From the center of the top rises a pine standard, *d*, ⅝ inch square and 5 inches high, secured by a single small screw passing upward through the box cover.

With this apparatus the condition of the hearing apparatus may be ascertained, and the hearing capacity may be accurately measured. It has been determined by the use of this instrument that there is a wide difference between the hearing powers of different individuals, and that there is often a marked difference between the hearing power of the two ears in the same individual.

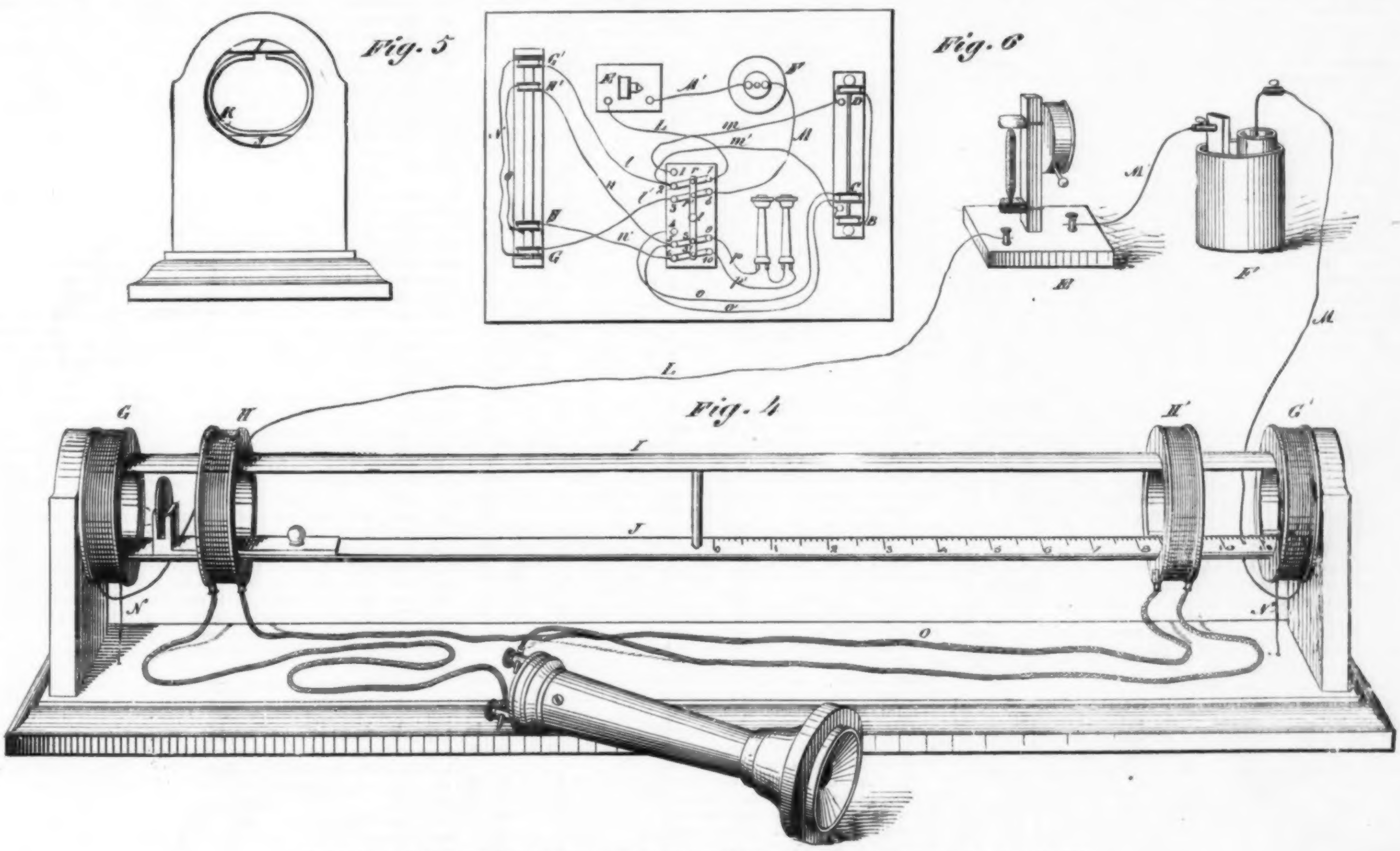
While this apparatus is very interesting, amusing, and instructive, another application of the same principle is even more wonderful. Figs. 4, 5, and 6 show the induction balance in a new and convenient form. This instrument is capable of being used in the same manner as that just described, and besides may be used to distinguish between metals and alloys by a method hitherto unknown.

As on several occasions the results of the examination of different metals by this method have been reported by Professor Hughes, and others who have experimented in this direction, only the apparatus and the method of using it will be described in this connection.

The coils, G, H, H^1, G^1, are wound upon spools 3¼ inches in diameter, having a 2 inch hole through the center for receiving the supporting bars, I, J. These spools are otherwise of the same dimensions and contain the same amount of wire as in the other case. The wooden bars, I, J, are 24 inches long between the standards that support them. They project through 2-inch holes in the standards, and are held in place by a horn or rubber spring, K, as shown in Fig. 5. This arrangement admits of inserting objects into the coils from the ends of the instrument. The primary coils, G, G^1, are in circuit with the microphone, E, and battery, F, and as in the case of the sonometer, they are connected so that the current traverses the coils in opposite directions, and the secondary coils, H, H^1, are connected together by one terminal, and with the telephone by the other, so that the secondary current traverses the two coils in opposite directions. The coil, H, should be placed ⅛ or ⅜ inch from the coil, G,* and the coil, H^1, should be similarly arranged in relation and the battery, F, are connected with the binding posts, 7, 8, of the switch. The contact points, 1, 2, are connected by wires, *m*, *m'*, with the primary coils, B, D, of the sonometer. The contact points, 2, 3, are connected by wires, *l*, *l'*, with the primary coils, G, G', of the induction balance. It will therefore be seen that by moving the switch arms, *r*, r^1, so that they come into contact with the points, 2, 3 (as in the cut), the current from the microphone and battery will be directed into the coils, G, G', of the induction balance, and that by moving these switch arms so that they touch the points, 1, 2, the current will be directed into the primary coils, B, D, of the sonometer. The binding posts, 9, 10, of the switch arms, *s*, *s'*, are connected by the flexible cords, *p*, *p'*, with one or more telephones;* and the points, 4, 5, are connected by wires, *o*, *o'*, with the secondary coil, C, of the sonometer, while the points, 5, 6, are connected by wires, *n*, *n'*, with the secondary coils, H, H^1, of the induction balance. By this arrangement, when the microphone is thrown into communication with the primary coil of either instrument, the secondary coil of that instrument is, by the same movement of the switch, thrown into communication with the telephone.

It has been determined that the volume and intensity of the sound for a particular metal, as indicated by the induction balance, is always the same; therefore, when the sound is measured by the sonometer, the particular degree which represents it is an index for that metal. The disturbing capacity of a metal or alloy is measured by switching the microphone and telephone from the induction balance to the sonometer, changing from one to the other until there is an exact equality in the sound in the two instruments. The degree at which the secondary coilof the sonometer stands will be an index for that metal.

Professor Hughes' apparatus differs from that above described in the following particulars: The scale of the sonometer is 40 centimeters between the primary coils, and is divided into millimeters. The coils of the induction bal-



NEW ARRANGEMENT OF HUGHES' INDUCTION BALANCE.

Two pieces, *e*, of ordinary battery carbon, having conical cavities for receiving the ends of the carbon pencil, *f*, are wired to the standard, one being connected with the wire, *i*, the other with the battery, F. The carbon pencil, *f*, is pointed at both ends, and rests only upon the extreme point at the bottom, while it is supported loosely at the top.

A small clock, *g*, is hung upon the standard, *d*, or if it is provided with legs it may stand upon the cover of the box.

The clock and microphone must be placed at such a distance that the listener at the telephone cannot hear the ticking directly.

Now supposing the whole to be connected in the manner represented and described. If the coil, D, is placed near the coil, B, the listener at the telephone will hear the clock ticking loudly. Move the coil, D, slowly toward the center of the scale, A, the ticking grows fainter and fainter, until finally it is not heard at all. With a normally acute ear the point at which the sound entirely ceases will be near 0; but the distance is found to vary greatly in different subjects. Move the coil, D, beyond 0 toward the coil, C, the ticking is again heard, at first faintly, then louder and louder, until the coils, D, C, come into contact, when it will be as loud as when the coil, D, was in contact with the coil, B. The current induced in the coil, D, in one case is the opposite of that in the other, but its intensity is just the same, and it produces exactly the same effect in the telephone. The currents in the coils, B, C, are equal but opposite; therefore one tends to counterbalance the effect of the other, and there exists between the two a neutral point where the coil, D, may be placed without being affected in the slightest degree. This point is in the middle of the scale, A.

The phenomenon of induction is most beautifully illustrated by this simple apparatus, and to one unfamiliar with the subject it is astonishing to hear in the telephone the sounds transmitted by the microphone without the slightest connection between the two.

to the coil, G^1, and should be moved one way or the other until the ticking of the clock on the microphone is no longer heard; then the inductive effect of one of the outer coils is exactly balanced by that of the other. To disturb this balance it is only necessary to insert in one or the other of the pairs of coils a coin or other object, as seen between the coils, G, H. The ticking may then be heard more or less distinctly in the telephone, the loudness of the sound depending on the particular metal or alloy inserted. If it be a coin, and another similar coin be inserted into the other end of the apparatus in the same position relative to the coils, H^1, G^1, the ticking will cease; but if there is a variation in composition or size, the difference is at once made known by the continued ticking of the clock in the telephone. In this manner a counterfeit coin may be easily and certainly detected.

It is remarkable that to disturb the balance of the current requires only the slightest variation in the size or material of the object inserted. A piece of small iron wire will bring out the ticking loudly. A piece of magnetized steel will make it still louder. It is an interesting study to determine the difference between different substances as indicated by this apparatus.

By connecting the induction balance shown in Fig. 4 with the sonometer shown in Fig. 1, in the manner indicated in Fig. 6, the sound given out by the secondary coils of the induction balance may be accurately measured by the sonometer, and the quality of any metal or alloy may be ascertained.

In the center of the diagram is seen a switch having four arms, *r*, *r'*, *s*, *s'*, connected by a vulcanite strip, *t*, and swinging on the binding posts, 7, 8, 9, 10. The free ends of these switch arms are capable of touching the contact points, 1, 2, 3, 4, 5, 6. The wires, L, M, leading from the microphone, E,

* This distance is made greater in the engraving simply for the sake of clearness.

ance are mounted upon vertical glass or paper tubes, two coils upon each tube, one primary and one secondary. The two tubes are placed at least one meter apart, and the distance may be much greater. A battery consisting of three gravity or Daniell cells is recommended.

When the induction balance is made in the form given in Fig. 4, the two central or secondary coils may be placed close together, and the apparatus may be used as a sonometer, a paper scale, K, being pasted upon the upper surface of the bar, J, to complete the arrangement. The two bars, I, J, are connected together at the center, to render them more rigid.

To insure smoothness in the movement of the coils upon their supports, the coils should be lined with cloth or felt. The holder used to introduce coins and other objects into the induction balance, should be made of some non-metallic substance, such as wood, rubber, or horn.

The cost of this apparatus is trifling, and it affords a world of interest and amusement. The experiments in induction may be modified in a very interesting way by removing two of the coils from their support, and connecting one with the microphone and the other with the telephone, holding the coils in the hands, and moving them toward and from each other, at the same time noting the effect in the telephone. The same effect may be produced by inclining one of the coils more or less to the plane of the other.

EXPERIMENT BY GAY-LUSSAC AND THENARD.

THESE chemists in their experiments on the preparation of alkaline metals passed the hydrates of potassa or of soda in vapor over an excess of iron contained in a gun barrel heated to the highest possible temperature. Hydrogen and vapors of potassium and sodium escape from the apparatus, and the corresponding oxygen remains fixed upon a part of the iron, but chiefly the part outside the furnace and relatively the least hot.—*H. Debray.*

* For full instructions for making telephones, see SUPPLEMENT 142.

THE INTERNAL CURRENT IN A VOLTAIC CELL.

*On a Galvanometer for Demonstrating the Internal Current transmitted through the Liquid within a Voltaic Cell.**

By CONRAD W. COOKE, C.E., M. Inst., T.E.

IT is of course well known that when the external circuit of a voltaic cell is closed, a current of electricity is transmitted through that circuit, and at the same time a current of equal strength is transmitted through the liquid within the cell from one plate to the other. These two are in reality but portions of the same current, and are for convenience known as the external or internal currents respectively, to distinguish that portion of the main current which flows through the external conductor from that portion which is transmitted from plate to plate within the cell. The former of these is detected by its electro-magnetic and electro-chemical effects, producing deflections in galvanometers and electroscopes and sounds in telephonic instruments, and is utilized in all the applications of voltaic electricity.

As far as the author has been able to find out, there has not hitherto been any satisfactory means in the hands of the demonstrator of physics by which the existence of the internal current within a single cell can be made apparent. Faraday, in the course of his early researches, made the following experiment: he suspended a magnetic needle by a silk thread and lowered it into the liquid between the plates of one cell of a voltaic battery, so that its length should lie in a plane perpendicular to those of the plates, and he observed that when the needle was just below the surface of the liquid it was deflected the moment that the external current was closed. On lowering it still deeper (the current being maintained complete), its deflection gradually diminished as the depth of immersion was increased, until it reached a position about half the depth of the liquid, when it returned to zero, and after passing this depth it was again deflected, but this time in the opposite direction, its amount of deflection in either case increasing as its distance from the neutral or central point was increased. The cause of this phenomenon is obvious from the following considerations: If a wire carrying an electric current be held above and parallel to a magnetic needle, the latter, obeying Ampère's law, will be deflected with an angular displacement, dependent upon the strength of the current and its distance from the needle; and if the same wire be held below the needle, the latter will be similarly deflected, but in the opposite direction. Now the flow of electricity through the liquid in a voltaic cell, may, for the purpose of this explanation, be looked upon as made up of an infinite number of currents transmitted in a horizontal direction from one plate to the other; and when a magnetic needle is immersed just below the surface of the liquid, all these currents are flowing in one direction below it, and a corresponding deflection takes place; when, however, it is lowered deeper into the solution, a certain number of currents are flowing below it, tending to deflect it in one direction, and a certain number are flowing above it tending to deflect in the opposite direction, and its permanent deflection is due to the electro-magnetic effects of the difference between the two. When these become equal, as they are when the needle is at the middle of its depth, their effects on the needle are balanced and neutralized, and no deflection takes place, and when that point is passed, the currents above the needle are in excess of those below it, and a corresponding deflection in an opposite direction is given to the needle. This is an interesting experiment, but is very difficult to repeat, on account of the feeble and unconcentrated nature of the electric currents above and below the needle, and the resistance offered to its motion by the liquid in which it is immersed.

Professor Hughes, by placing in the current of a battery an apparatus, such as a clock microphone, or a key by which an intermittent or undulatory character may be given to its current, and holding one side of a rectangular coil of wire in circuit with a Bell telephone over one of the cells of his three cell battery, induced a secondary intermittent or undulatory current in the coil by that portion of the primary circuit transmitted through the cell, and a corresponding ticking was heard in the telephone.

In both these experiments, however, the effects observed must be attributed rather to the external current of the other cells than to the internal current of the cell under experiment; and the author is unaware that any successful attempt has hitherto been made to construct an instrument which shall utilize the whole of the internal current of a single voltaic cell for the production of electro-magnetic effects. When engaged in some experiments a few years ago, it occurred to the author that if a voltaic cell were divided into two portions, having the zinc element in one portion, and the positive element in the other, and the solution contained in the one portion were connected to that in the other by a tube filled with the same liquid, the tube being coiled round a magnetic needle, a deflection of the latter, due to the current within the cell being forced by the convolutions of the tube to circulate around the needle, would be produced when the two elements were connected together, and the apparatus shown on the diagram was constructed. This will be seen to consist of two glass tubes closed at their lower ends with perforated corks through which the ends of the coiled tube are inserted. Within the rectangular coil of the tube was suspended a magnetic needle, and the whole having been filled with diluted sulphuric acid, a plate of zinc was placed in one tube and a stick of carbon in the other. On making connection between them by means of a wire, a slight deflection took place, but owing to the feebleness of the current, the directive action of the earth's magnetism and the friction of the pivot, the instrument was not sensitive enough to be satisfactory, and the author therefore designed the instrument which is exhibited on the table, which consists of two glass test-tubes united together by a small tube about two feet long, and convoluted into two circular coils, after the manner of Thomson's reflecting galvanometer. Within the coils is suspended an astatic system of magnetic needles, of which the upper carries a light mirror, by which its deflections may be made apparent by the movement of a spot of light on a screen. It may, therefore, in this respect be looked upon as a Thomson's reflecting galvanometer, coiled with liquid instead of with metallic wires. The elements are placed one in each of the little cells, and may be connected by a key; or, by placing a reflecting galvanometer in the external circuit, both currents may be simultaneously indicated on the screen, and their independence or identity be demonstrated.

The first instrument constructed by the author was made by connecting the two cells by means of a tube of India rubber coiled round two cardboard cylinders; but through the kindness and unrivaled skill of his friend Mr. Gimingham, whose name is now inseparably connected with the splendid researches of Mr. Crookes, he was able to produce the instrument on the table, in which the tubes and coils are of glass, all in one piece, and it is a very beautiful specimen of accuracy of glass blowing. Below the base of the instrument is a fine, slightly magnetized sewing needle, which can be rotated on a vertical axis through a small angle by means of a little lever, and by which the instrument may be adjusted to zero.

The author has been induced to bring the instrument before Section A of the British Association, in the hope that it may be useful, not only for science teaching, but for aiding investigations connected with the physical action of the voltaic battery.

* Paper read before Section A of the British Association at Sheffield, August, 1879.

ABSTRACTS OF CHEMICAL PAPERS.

Products of Distillation of Alcohol.—By I. PIERRE and E. PUCHOT (*Compt. Rend.*, 88, 787-790.—In the rectification of commercial alcohol, the liquid at a certain stage of the distillation assumes a color varying from a sage-green to an intense yellow; this liquid in contact with the skin produces a stain similar to that of iodine. There also distills over a liquid having a strong smell of pepper, and at the end of all the distillations there remains in the retort an oily residue floating on the water, which sometimes resembles tar in appearance, and which distills between 200° and 330°. The authors having reproduced these phenomena synthetically, find they are produced by the action of dilute alkaline solutions on the aldehyde present, which causes certain modifications and condensation products of the aldehyde, resulting finally in the formation of aldehyde resin which distills between 200° and 330°. L. T. O'S.

A New Alkaloid.—By A. PETIT (*J. Pharm. Chem.* [4], 29, 18-20).—The author describes a white, bitter root, whose origin and name are at present unknown to him. Its starch granules are much smaller than those of wheat. It contains much saccharine matter, nine-tenths of which has no reducing action. When coarsely powdered and extracted with alcohol at a temperature of 80°, it yields an extremely bitter solution. The alcohol was distilled, the residue taken up with water, and the filtered liquid mixed with potassium bicarbonate and chloroform. Several treatments with chloroform were necessary to remove the principle entirely; the chloroform solution was strongly alkaline. A sirupy residue remained on distilling the chloroform, and this crystallized the next day in tufts of fine needles and very long prisms. A trace of color was removed by treatment with well washed animal charcoal. The body shows all the properties of the best defined alkaloids, neutralizing the strongest acids, and yielding precipitates even in dilute solution with the double iodides of potassium and mercury, with the double iodides of potassium and cadmium, and with gold chloride. No particular colorations are obtained by the reactions for strychnine and for quinine. The alkaloid is characterized by its extreme bitterness, its great solubility in water, its inactivity toward polarized light, and by the solubility of its platino-chloride. Other reactions are stated. Its physiological action was inappreciable when tested by hypodermic injection on frogs. F. C.

Composition of Wood.—By J. THOMSEN (*J. pr. Chem.* [2], 19, 1461-68).—The action of cold dilute caustic alkali on the wood of trees of the birch class results in the withdrawal of a substance which is isomeric with cellulose, $C_6H_{10}O_5$, and to which the author gives the provisional name of "wood gum" (*Holzgummi*). This substance is identical with the "Pectin substance" of Poumarède and Figuier (*J. pr. Chem.*, 1847, 42, 25). Wood gum is most easily prepared from beech sawdust, by digesting with ammonia solution, washing, again digesting with caustic soda, filtering, precipitating the filtrate with alcohol, washing with alcohol, digesting with a little dilute hydrochloric acid to remove mineral matter, repeatedly washing with alcohol, and finally with ether.

As thus prepared, wood gum is a colorless powder, insoluble in cold water, but soluble in about 50 parts of boiling water, forming a liquid which becomes opalescent on cooling, and yields a copious precipitate on addition of a drop of dilute hydrochloric acid, acetic acid, sodium chloride, caustic soda, or sodium acetate solution; it is insoluble in alcohol. No coloration is produced by addition of iodine tincture to a solution of pure wood gum.

Wood gum is found in the wood of leafy trees, but is not present in that of conifers; the quantity of this substance in the wood of any tree increases as the axis of the trunk or branch is approached; old wood contains smaller quantities of wood gum than new wood. The following table shows the amount per cent. separated from different woods.

	Birch.	Beech (old).	Beech (young).	Do. No. 2.	Ash.	Elm.	Oak.	Cherry.
Periphery,	13·9	8·2	11·9	13·8	9·7	8·9	14·4	19·3
Middle,	19·7	15·9	11·3	15·9	10·7	12·0	10·7	15·4

M. M. P. M.

Phosphorescence of Lobster's Flesh.—By C. BANCEL and C. HUSSON (*Compt. Rend.*, 88, 191).—A microscopic examination of lobster's flesh, when phosphorescence appeared, showed the presence of reddish yellow cells, which the authors regard as acting like plants, during the daytime, in fixing carbon and liberating oxygen, which last remains dissolved in the liquid, while the germ continued to live evolving carbureted hydrogen and phosphureted hydrogen from the surrounding material, and these products are oxidized as they form, producing the phosphorescence. R. R.

Assimilation of Soda by Plants.—By DEHERAIN (*Chem. Centr.*, 1878, 783-784).—Beans grown in water containing sodium chloride alone in solution assimilated the salt in small quantities, but if other salts were present in the water, sodium chloride was taken up only when its proportion was large compared with that of the other salts. The other salts employed were calcium and potassium nitrates. Beans grown in water containing 1 gramme of each of the three salts, showed no trace of sodium in their ashes; if, however, the proportion of sodium chloride was raised to 4 grammes, a small quantity was assimilated. In such a solution the plants lived several days, whereas in one which contained 4 grammes of sodium chloride only, the assimilation of that salt was rapid, but the plants very soon died. The author finds that soda is taken up from the ground by beans only when its proportion to the other salts is large, and hence the absence of soda in the ash of the plant does not necessarily prove that the soil in which it was grown was free from soda, but may arise from the soda being mixed with sufficient quantities of other salts.

The laws of diffusion offer no explanation of the fact that sodium chloride is more readily assimilated in the absence of other salts. The author finds that when beans which had begun to germinate were placed in salt water, they frequently removed more salt than water; Böhn had shown that distilled water cannot support their growth, but that water containing calcium salts readily does so; hence the author concludes that the germinating beans assimilate by preference calcium and potassium salts, and take up sodium chloride only when the calcium and potassium salts are absent or are deficient in quantity relatively to the sodium chloride. F. C.

Evaporation of Water from the Ground.—By F. HABERLANDT (*Chem. Centr.*, 1878, 830).—Glass cylinders of similar dimensions were filled with cultivated soil, sand, and "bog-earth" respectively; they were moistened with varying percentages of water, and their loss in weight by evaporation compared with that undergone by a similar cylinder of water at the expiration of four and of 24 hours. It was found that the evaporation increased with the percentage of water added, that it was augmented remarkably by rise in temperature of the air, and that moist sand and soil lost more by evaporation than the water itself. The rate of evaporation rapidly diminished if the loss of water was not made good. In comparison with the water given off by transpiration of plants, the evaporation from the surface of the soil is very great. It is evident from the above results that although repeated light showers will not penetrate to the roots of plants, the same quantity of rain falling in one shower may do so. The loss by evaporation was much lessened when salt water was substituted for fresh in moistening the soil. F. C.

Adulteration of Beeswax.—By BUCHNER (*Dingl. polyt. J.*, 231, 272).—On account of the high price of beeswax, it is often largely contaminated with talc or resin. For several years cerosin has been added to beeswax in large quantities, as much as 33 to 50 per cent. having been found. This substance is a mixture of purified ozokerite and carnauba wax, and resembles beeswax in appearance. Its presence may be detected by the sp. gr., that of the adulterated product being lower than that of pure beeswax. The sp. gr. of yellow raw beeswax is 0·959, of white wax 0·955. Since carnauba wax imparts to cerosin its hardness, soft cerosin is lighter than the hard wax, the density of carnauba wax being 0·999. To detect admixture of cerosin, the wax is boiled in a test tube with a concentrated alcoholic solution of potash (1 pt. KHO in 2½ to 3 pts. 90 per cent. alcohol) for a few minutes, and kept in the water bath for some time to prevent the mixture from solidifying. The solution will remain clear if the wax is pure, but paraffin floats on the surface if it is adulterated with cerosin. D. B.

Plastering of Wine.—By E. POLLACCI (*Gazzetta Chimica Italiana*, 8, 379-388).—In the south of France it has been the custom from ancient times to add plaster to wine or to the must, with the object of brightening the color, and to render the wine capable of sustaining long voyages without undergoing change. From France the practice passed into Spain and Portugal, and subsequently into Sicily and into Sardinia. It was not, however, until the year 1853 that the use of plaster became general in this locality. According to the author, the plaster is added to the grapes in the tun, being sprinkled over the layers of grapes in the proportion of about 1-3 per cent.; as, however, is it not usually weighed and costs but little, it is frequently added in larger quantity than that just indicated. The present paper contains an account of an elaborate series of experiments made to ascertain the effect of adding plaster and pure calcium sulphate to wine, reserving its effect on must for a subsequent communication. A white wine from S. Colombano at Lambro was employed, dry and limpid, and the results obtained show that the calcium sulphate reacts solely on the cream of tartar, producing potassium-hydrogen sulphate, which remains in solution, and calcium tartrate, which is precipitated for the most part. This reaction, however, is only partial, as the wine still contains not only calcium sulphate, but also cream of tartar equal to about half that originally present. With pure calcium sulphate, the degree of acidity of the wine remains about the same as it was before treatment, but with common plaster which contains calcium carbonate, it is reduced.

Plastered wine, generally speaking, may be regarded as a saturated solution of calcium sulphate and tartrate, still retaining the natural constituents of the wine, and also containing potassium-hydrogen sulphate (about 1 gramme per liter); it must be remembered, however, that the calcium salts mentioned are more soluble in plastered wine than in pure water. On evaporating to one tenth of its bulk, plastered wine or dilute alcohol in which pure calcium sulphate and potassium hydrogen tartrate have been allowed to react, a residue is obtained containing free sulphuric and tartaric acids. It has yet to be ascertained whether these acids are formed by the reaction between the two salts, or by secondary reactions during concentration of the solution. Thus, a small proportion of free sulphuric acid, found in an evaporated wine, cannot be considered as evidence of adulteration. The addition of plaster to wine already fermented, although the most simple and least hurtful form of plastering, profoundly alters the composition of the wine, introducing into it about a gramme of potassium sulphate per liter, besides a not inconsiderable quantity of calcium sulphate and tartrate. C. E. G.

A Black Lac for Metal and Wood.—A mixture is made of 500 grammes of methyl alcohol and 90-100 of gum lac in powder; in a separate vessel 500 grammes of coal tar benzene are mixed with 100 of asphalt. Both mixtures are stirred occasionally for 2 or 3 days, then mixed together in equal parts and lampblack added. The mixture can be made thinner if necessary, by adding a mixture, in equal proportions, of alcohol and benzene. F. C.

NOTE ON CHARACINE.

By DR. T. L. PHIPSON, F.C.S., etc.

AMONG the organic substances present in fresh water is a new and interesting product, to which I have given the name characine, for reasons that will appear presently. It is the substance to which algæ in general—such as confervæ, oscillariæ, desmids, etc., and the plants of the genus *Chara*—owe their peculiar odor, and communicate this odor to the water in which they abound.

I have obtained it, in minute quantities only at present, from *Palmella cruenta*, from *Vaucheria terrestris*, and from several Oscillariæ (*Oscillaria autumnalis*, *O. tenuis*, etc.). It is, apparently, more developed in the genus *Chara*, and *C. fœtida* will, I believe, yield it in larger quantity than the plants already mentioned. It is also plentifully produced by the dark colored Oscillariæ growing on damp walls, and by *Nostocs*.

Characine is a kind of camphor which gives to these plants, and to the waters in which they grow, that peculiar, highly

characteristic, marshy odor, which is usually ascribed to products of their decomposition, but which is due entirely to the substance here described, produced by the plant in life and health. It is formed not only in those algæ which live entirely in water, but also by those, such as *Palmella* and *Oscillaria*, which flourish in moist places, and are occasionally subjected to desiccation. It is sometimes seen floating in extremely thin films upon the surface of stagnant waters and on that of tanks in which algæ are cultivated. I obtained it first from *Palmella cruenta* whilst studying its curious pink coloring-matter, palmelline, recently described in a note to the Paris Academy (of which remarkable substance I shall soon have more to say).

When a certain quantity of alcohol, in which this plant has steeped for some twenty-four hours in a closed tube, is diluted with fifteen to twenty times its volume of water, and then (the grains of chlorophyl having been allowed to deposit and the liquid decanted) shaken up with ether, the latter dissolves the characine, and leaves it on evaporation as a white greasy substance, having a strong and characteristic marshy odor; non-saponifiable by potash; lighter than water; gradually volatilizing into the air (or disappearing by oxidation) from the surface of water on which it floats, and which thus loses its odor entirely in two or three days; soluble in alcohol and in ether, but nearly insoluble in water. (When heated with water in a closed tube it was transformed into a substance similar to vegetable wax, melting at 83° C., and having the odor of that substance; but this effect might have been due to some impurity.) A better method of obtaining characine in a pure state is not to employ alcohol, but to operate as follows:

The *Palmella* or *Oscillaria* which is to be treated must be previously dried by exposure to the air, at a temperature not exceeding summer heat, for about twenty-four hours. The "dry" substance is then covered with cold water in a capsule, which must itself be covered with a sheet of glass, and in the course of about thirty-six hours more (with *Palmella cruenta*) thin films of characine will be observed floating on the water. The latter is then decanted off into a long tube, together with the films (which are apt to stay behind in the capsule), and shaken up with ether as before mentioned. In this case the product is perfectly white, quite devoid of crystallization, more or less unctuous in appearance, whilst that obtained by the use of alcohol has often a yellowish tint, and is probably impure. Up to the present time I have not obtained it in sufficient quantity to ascertain more of its properties.—*Chemical News.*

BLEACHING OF SUGAR SIRUPS BY OZONE.

By ALBERT R. LEEDS.

NOT being able to find in chemical journals any accounts of experiments upon colored sirups with ozone as a bleaching agent, while there were rumors that many such had been tried, it appeared the readiest way of obtaining information to institute suitable trials, with quantitative determinations of the amounts of ozone employed and of the degrees of change effected.

The material was kindly furnished by Dr. Arne Behr, from sirups manufactured in the refinery of Messrs. Matthieson & Weichers, Jersey City. The first specimen was of sirup which had undergone but one filtration, and was of a brownish yellow color. In this preliminary experiment the amount of ozone required to effect the bleaching was not determined. At its close, the sirup was of a faint straw color and of slightly acid reaction.

A second trial was made upon a sirup which had been twice filtered, still retaining a strong yellow tint. Twenty c.c. of the sirup were introduced into a Geissler absorption apparatus, and a slow current of oxygen, ozonized to the extent of 24 mgrms. ozone per liter, passed through it for several hours. When about 100 mgrms. ozone had been brought into contact with the sirup, it had become almost colorless. To my own litmus-paper it was neutral, although Dr. Behr informs me he detected a very feeble acid reaction.

As determined by Dr. Behr, the filtered sirup when it came from the refinery contained, in 100 parts, 50 parts of dry substances and 40 parts of dry sugar. The alteration in the course of bleaching is seen in the following table:

Effect of Ozone upon Filtered Sirup.

Dry Substance contains.	Unbleached.	Bleached.
Cane-sugar (by polariscope)...	79·7 p.c.	80·0 p.c.
Inverted sugar	12·7 "	12·7 "

—*Chemical News.*

THE TRANSFORMATION OF STARCH INTO DEXTROSE IN THE COLD.

STARCH, it is known, is slowly transformed into dextrose when boiled for a long time with water. Riban has made some observations which seem to show that the same result may be arrived at in the cold, though much more gradually. A solution formed by boiling one part of finely-divided starch in one hundred of water saturated with salt, and filtering the same, is imputrescible, and may be preserved for a long time. After a year the author's solution appeared to be less sensitive to iodine, and after three or four years was no longer colored by that reagent. It was neutral, limpid, contained no trace of any organized ferment, reduced the copper solution energetically, and was colored brown by alkalies. Determined by the copper test, every 100 c.c. contained 0·111 gramme of dextrose; but when ferrocyanide of potassium was employed, which is not affected by dextrin, 100 c.c. contained 0·102 gramme. A mixture of nine-tenths dextrose and one-tenth dextrin was consequently formed from the starch. The solution in a tube 200 mm. long rotated to the right: $D\alpha = +0{\cdot}15°$. The author calls attention to the importance of the transformation of starch in the cold without a ferment in its bearing on the physiology of vegetable growth.—*Bull. Soc. Chim.*

THE PREVENTION OF INFANTILE OPHTHALMIA.

A WRITER in the *British Medical Journal* advises as follows, in order to prevent the ophthalmia of new born children:

The instant the head is born, and before the child has time to open its eyes, I wipe away from the eyes every trace of moisture. In this way the entrance upon the conjunctiva of all acrid discharge from the vagina is prevented. I have attended to this point in hundreds of cases, and have never known it to fail; while, in the same period, ophthalmia has repeatedly occurred in those cases where the child has been born before my arrival. Carefully to wipe the eyes of the child at the earliest possible moment has now become with me so much a point of routine that I never omit it, even in forceps cases, or in the uncommon presentations, and the result is the absence of the disease alluded to.

EMOTIONAL PRODIGALITY.*

By C. FAYETTE TAYLOR, M.D., New York.

I AM quite aware that it is no new thing to attribute bodily injury to mental overwork in young and old, and the evil habits of society are constantly heavily charged with many of our ills. But the fault lies in too broad generalizations and too few intimations, even, of the specific direction from whence the evil charged has come. Hence important facts, which society acknowledges as general truths, produce small effect in changing the course of events. People go on as before, not because they do not now know, as a general fact, that mental overwork is injurious, but because they have not been informed in regard to the way in which it is injurious, and have little definite knowledge of methods for avoiding what they do not see clearly is to be especially avoided. Knowledge concerning the mind is like all other knowledge, it must be definite before it is capable of practical application. So that it often happens that persons who are perfectly aware that they are suffering in bodily health from mental overwork, in their anxiety to correct the evil, and in their ignorance in regard to its source, often take courses calculated to increase, rather than diminish, the mental strain from which they suffer.

In the first place, the mind, as a whole, may be said to be made up of several distinct parts or attributes. Some of these attributes may be active while others are at rest, and they all have very different and very independent and distinct relations to, and influence over, the bodily functions. For instance, one of the most common errors is the supposition that thinking, as distinguished from other mental activities, is the source of injury when one's health suffers from excessive mental strain; whereas mere thinking, disassociated from other mental phenomena, is one of the least likely to be in excess of the individual capacity to bear, and the least exhausting in any degree. In fact, it is unquestionably true that an active, well-trained *thinking* capacity imparts positive strength to the bodily powers, increasing both health and longevity. It isn't the *thinking* which breaks people down, but it is an excess—often an unnecessary excess—of other mental activities which works the bodily injury; and by "other mental activities" I would especially include the *emotions* as the most exhausting of all mental attributes. It is the emotion which so often accompanies thought which tires and exhausts the frame, when it is supposed to be the thinking which does the injury.

A well-known professor of theology, who had several times broken down from mental overwork, once told me that he had noticed that while recovering, after a period of rest, he would arrive at a point at which he could go on with his purely intellectual work with perfect ease and facility when he could not listen to a sermon, the emotions being then brought into play, without being completely overcome and physically prostrated by it. And what is true in the case of this theological professor is true with us all—we are not likely to be injured by purely intellectual work. It is only when the emotions are excited that the excessive drain on the bodily powers begins, to any injurious degree. This statement is confirmed by the well-known fact that cool and well-regulated dispositions are those which, as a rule, last the longest; men of even temperaments, or those who have disciplined themselves to habits of uniformity and equanimity, are those who do the largest amount of intellectual work, and do it with the greatest ease.

But excitable temperaments, those who easily become aroused, and who find it difficult or impossible to subjugate their emotions, are the persons who can do the least intellectual labor and who suffer the most bodily harm from mental activity, when in excess. The fact is, what and how much we do is of much less concern than the way we do it. The calm and placid man can go on for ever, like the smoothly-flowing river, with his intellectual labors, while the emotional person is exhausted by his emotions even before he begins to think. We see this difference well enough in men; we see the different amounts of mental as well as bodily labor which they can do, varying according to the nervous waste going on through their emotional activities, rather than measured by actual thinking.

But the contrast becomes stronger when we observe the mental operations of women. Characterized as a sex with less manifestation of independent thinking, whether from a feebler endowment of reasoning powers, or whether because the intellect is so habitually subordinated to simple feeling, it is not necessary to discuss. But it is certain that the women of civilized communities are more emotional than are those of less favored regions, or else my observation has been at fault. While education in men makes them self-controlling, steady, deliberate, calculating, thinking out every problem, the intellectual being the preponderating force, the so-called "higher education" for women seems to produce the contrary effect on them.

I am willing to admit and believe that it is not the fact of being educated which produces contrary effects in men and women, but the different ways in which men and women are educated. Still, it holds true that while men are calmed, women are excited by the education they receive. The emotions in savage men are the ruling forces, while they are subordinated to the intellect in the educated man. But the woman who has been put through the process deemed necessary to acquire the "higher education" is nervous, excitable, and in every way more dominated by her emotions than the savage woman is. Or, if the contrast is not so extreme as this, she certainly does lack that equipoise which is the characteristic of highly educated men.

In my capacity of surgeon I have frequent occasion to observe how different classes of women act under corresponding circumstances. My experience is such that I do not want a so-called highly educated woman to take care of a case of hip-joint disease, for instance. For patience, for reliability, for real judgment in carrying out directions, for self-control, give me the little woman who has not been "educated" too much, and whose only ambition is to be a good wife and mother. She can be trusted to keep cool under trying circumstances; she does not have the backache; she does not tear herself to pieces with imaginary troubles, nor insist on taking only emotional views of every incident of life. Her reason has not been put under the dominant influence of unmixed feeling, intensified by the process through which she obtained what is called her education. Hence her head is cool and her judgment clear. Such women are capable of being the mothers of men. But modern communities have too few of the even-tempered, such as I have just described. Civilization is not an unmixed good; it carries penalties as well as compensations in its train.

It should not be lost sight of that women are emotional as a class of human beings, and there are many things incident to civilization which tend to increase to extraordinary proportions the emotional characteristics which pertain to them by virtue of their sex. The æsthetic form of emotion is so ready to be made prominent, and is so pleasing in its legitimate expressions, that some form of emotional exercise very easily becomes the principal feature of female education, so that the first we know, unless, happily, we are continually on the watch, the girl whom we send to school is increasing the intensity of her feelings much faster than she increases her stock of knowledge.

I am not, at this time, discussing how this can be changed. I only desire to call attention to facts which must be familiar to every one. Thus tendencies endowed by nature, which would only harmonize her being to her position and destiny under favoring conditions, become exaggerated by inheritance and intensified by the education of the schools and the atmosphere of society, till the woman of our modern civilization becomes the bundle of nerves which she is, almost incapable of reasoning under the tyranny of paramount emotion, and some of them wholly incapable of becoming the mothers of rightly organized children. So the children are born many of them with big heads and little bodies and almost no digestion at all, but whether born feeble or vigorous they are ushered into an atmosphere of an intensely emotional character. Whatever may be the stimuli to intellectual activity, there are ten or a hundred fold more agencies which act on the emotions alone.

INJURIOUS EFFECTS OF EMOTIONAL EXCITEMENT IN CHILDREN.

It is to the fact that children are brought up in a hotbed of emotional excitements to which I wish to call your attention. It is sufficiently deleterious to incite mental activity prematurely; but to prematurely and unduly excite emotional manifestations is tenfold more hurtful. It is just here that there seems to be the densest ignorance. Children are made to minister to adult morbid craving for emotional excitation by having their own emotions brought prematurely and excessively into action, just as if their powers of endurance were unlimited in this direction.

People, and especially the female portion of society, do not stop to reflect that all the fondling which children (American children, I more especially mean) receive is not for the children's, but for their own sakes. Children are literally made to become little actors; but their fond relatives are not content with an hour or two a day, which is considered sufficient for adult actors, but they are kept going from morning until night. In my large practice among children I am certain that scores are literally killed by the excessive amount of emotional excitement which they are forced to endure. And much of it is, when we properly analyze it, from a purely selfish source. All this hugging and kissing and talking to them is to excite responses of the same emotional nature in the child for the pleasure and gratification of the parents and friends. There is really no thought that it is for the child's good. They are not content without securing some response, some prattle that shall be considered pretty, some embrace that betokens warmth of feeling, some witty saying that shall show smartness and sentiment, some act which shall thrill the family audience with delight.

In fact, our children are made the means of filling us with thrill after thrill of delight through their responses to the emotional manifestations which we purposely and for our own selfish pleasure excite within them. But at how great a cost! It does not better the matter that people are not generally aware that it is their own and not always the child's pleasure which they seek in the excessive fondling which I am deprecating. Because they do not recognize the purely selfish character of the motive which makes children act day by day for the pleasure of the family is the reason that it is done; and it is the reason also, I may say, that I think it my duty to raise a warning voice against the pernicious practice, at some risk of denunciation, I am very certain. For it is a delicate thing to trench on the private ground of personal feeling and dispute with a mother how much and in what way she may love her child. But I hold that there is not a relation in life which may not be criticised in the right spirit, nor is there one which ought to be left to blind instinct or unreasoning impulse.

Even maternal love may be a purely animal feeling, and, when exercised without reason it may become an engine of cruelty and even death. Many such cases I have seen; one illustration will suffice for all. A mother brings her little child to me for a disease which is curable if immediately attended to, but fatal if appropriate treatment is delayed. I explain it all to her complete understanding. She sees that it may be cured, for she sees others like it which have been cured. She also understands that the chances are against its recovery, because she meets others in sorry straits who have neglected or delayed. But she will not leave it. There are those who can remain—an aunt, an older sister, a faithful nurse. All to no purpose. The mother has, perhaps, a younger child at home, and cannot herself remain, and so the sick one must go home to die, or, what is far worse, to endure years of agonizing suffering, and then to live a short, decrepit life, with all bright hopes blotted out for ever. This is what unreasoning animal affection may do, and what it is continually doing, to my certain knowledge.

Another child, a beautiful girl, lives in its grandfather's family. Of parents and grandparents, of uncles, aunts, cousins, and friends there are seventeen. It is the only grandchild, and the household draws a certain large portion of its daily emotional pleasures from this babe. It continually passes from lap to lap and from lip to lip, not allowed ever to go without returning some pretty prattle for the urging and caressing which she receives from morning until night. What wonder is it that evening finds her tired, peevish, excitable, and wholly exhausted? And when disease attacks her it finds weak resistance in a frame already enfeebled, at the tender age of four, by an overwrought brain. In this case I could manage the mother, with whom I came in personal contact. But she found it impossible to make the other members of the family let the child alone, and she was actually obliged, under my advice, to imprison herself in a room with locked doors to keep her sickly child from continuing to be the plaything of the family.

Now, what is the result of the system of child-management which keeps the young mind in continual excited tension?

There is a law of human force which proclaims that for every atom used in one direction there is an equivalent atom wanting in some other direction. How can there be a well-developed body in a child whose brain is kept excited and in whom a waste of force is going on far beyond the means of supply, except by drawing it from other directions? Thus the brain is supplied, in part, at the expense of the body; that is, the body is starved to support the brain, excited by the mind into unnatural and premature activity. And the

* Read before the New York Odontological Society, March 18, 1879.—*Dental Cosmos.*

worst of it is that there are no proper compensations. On the contrary, a condition of preternatural emotional preponderance is established as the inveterate habit of life. Hence the so-called "nervous" invalids, which exist in all civilized communities, and are especially abundant in this country: persons who are frightened at any sudden noise, and whom the sight of a mouse throws into a cold perspiration. No matter how sensible they may be in calmer moments, their reason is dethroned and subordinated by the superior influence of easily excited emotions.

Such are the persons whose flabby muscles and nerveless frames are only surpassed as a phenomenal fact by the amount of pain they can bear and still exist. Such persons are the products of civilization—of that civilization which does not seek for and find the causes of its abortive products and endeavor to so arrange the checks and balances supplied by intelligence that the race shall not deteriorate through preventable causes. For the causes are largely preventable, and preventive means are daily used among those who are better informed on the subject. But there should be greater precautions used against the overaction of the brains of children, and it should be better comprehended that the overaction comes, for the most part, from the direction of the emotions.

My professional life is spent, for the most part, in attending to children, and I have ample opportunities to see the evil effect on the bodily development of overwrought emotions. Feebleness, asymmetry, excitability, premature arrest of growth, are some of them. So that populations of cities, which come under the influence of more things which tend to excite emotion, become less and less in size until, it is said, that cities would cease to be if it were not for the constant influx of persons who were reared in the country, and so escape some of the body-dwarfing influences to which the children of large centers are so much subjected. The extent to which the influences under consideration go no one would imagine, perhaps, unless he were in actual contact with large numbers of children.

I may say that at least two-thirds of all lateral distortions of the spinal column are directly traceable to mental overaction, mainly, if not entirely, of an emotional origin. There can be no doubt that this is the fact, because not less than three-fifths of those of them who consult me in the earlier stages recover without any other treatment than a careful abstaining from whatever excites undue emotions in the subject of the distortion.

One little incident occurred a number of years ago, which may serve to fix the moral in your minds if I should relate it. Being in Wilmington, Delaware, at the time, I was consulted by a lady concerning her daughter, who had begun to give evidence of curvature of the spine. She was a good-sized child of about twelve, and I sought in vain, for some time, to find a cause for the weakness of the muscles which allowed the bending of her spinal column. Her lessons did not seem to be too much for her, her exercise was regular and sufficient, her food was proper, and, altogether she seemed to be well managed. Still, there was an expression of fatigue in her face, and, although her rapid growth was exhausting her somewhat, as is always the case, that alone did not seem sufficient to cause the spinal muscles to give way and the spinal column to bend out of its proper direction. So I inquired particularly in regard to any outside influences which might tend to excite the child's emotions; but such inquiries were met by prompt denials.

The mother was an unusually intelligent woman, and seemed to comprehend the subject better than most. Two days afterward, this mother returned to say that perhaps she had found the source of the child's loss of power, for she was often nerveless and languid. She said that this girl was an especial favorite of her husband's mother, and that it was her custom to pay her grandmother a visit twice every week; she added that, now that her attention had been called to the subject by my inquiries, she remembered that her daughter invariably came home from those visits tired, nervous, easy to cry, and she was always glad to get her off to bed as soon as possible, and even the next morning there were often traces of the nervous excitement which she showed more especially the night before. Her grandmother, the lady said, was a very intellectual woman, and the child looked forward to her bi-weekly visits with great anticipations, but if I thought they had anything to do with the curvature she would stop them at once. I replied that I had no doubt but that they had, and they were accordingly put an end to. In other respects no change was made in her course of life. Three months later I was in the neighborhood, when the child was brought to me, this time perfectly straight. Ceasing to visit her grandmother had cured a curvature of the spine: cured it by preventing the bi-weekly exhaustion through excessive emotional excitation; thus muscular tone was restored.

As before remarked, growth, especially rapid growth, is an exhausting process, and it is of the greatest moment that the process of natural growth should not be interfered with by unusual demands made on the nervous forces at the same time. Indeed, I think there is even more danger to the health in excessive mental strain during the period of rapid growth at the age of puberty than in childhood even. This is especially true in regard to girls. Their growth is generally more rapid than it is in the other sex. They pass through a stage of physical development in one or two years which boys require five or six to perfect. There is a correspondingly greater danger of overtaxing girls at this age.

If we add to the natural bodily growth the development of the sexual functions, the important changes which take place in advancing from girlhood into womanhood, all accomplished within a short period of time, and each one a special tax on the vital powers, we can better comprehend how the human female is subjected to great and special causes of nervous exhaustion of a perfectly normal character at this period of her life. In fact, all human beings, at this time, pass through what may be called a vulnerable period, pass through safely enough when the circumstances surrounding them are favorable, but not without damage when their vulnerability, at this time of life, is not comprehended and guarded against. So severe are the demands made upon us at this time, so completely absorbed are our nervous energies in the work of bodily growth and the development of special functions, that, under natural conditions, the action of the brain is somewhat retarded, and we find, between the ages of twelve and fourteen or fifteen, varying in different individuals, a well-defined period of mental sluggishness.

Girls and boys at that age are said to be "green," which means that they are employed, absorbed, as they ought to be, in the more important acts of becoming men and women, and that, for the time, there is but little left for mental activities. This is nature's method. Let them alone and they will grow into full-sized men and women. Their frames will be strong and well knit, their muscles firm, their organs of digestion and assimilation sound, and their functions vigorous and healthy. After the growth has been completed and the functions established, there is a rest and a respite. The mental faculties now wake up, there is more abundant material to feed the brain, now that there is less call in other directions, and we have the pleasant spectacle of a "sound mind in a sound body."

But what are the facts regarding modern and, especially, American civilized children? I speak still more especially of girls, because they are affected more by elements which disturb the natural order of things than boys are, though boys do not escape unharmed, by any means. Cunningly devised means for exciting feeling only, begun at the cradle, are continued through child-life up to the very verge of womanhood. The æsthetic alone, or almost alone, seems to be the sole idea of female mental existence. Thus they arrive at twelve or fourteen, and on the threshold of the most important period of existence, utterly unfitted for passing through it. Excitable, with wide-open eyes and ears for every sight and sound which can excite feeling, rapid and intense in mental activity, with thin limbs, narrow chest, and ungainly back, we meet these twelve year old products of civilization going to school with an average of thirteen books under their feeble arms, for I have found by actual count that thirteen is the average number of studies which they "take" nowadays. Do they study them? Undoubtedly, for the sake of being at the head of the class, or of not being at the foot, or to recite them or to *say* they study them, etc. But you will find almost invariably some emotional motive connected with the education of girls, as now conducted, in the majority of instances.

Now, what is the girl's chance for perfect development under such adverse conditions as those which I have briefly pointed out? The chance is poor indeed, and the result is deplorable. With the mind thus forced to an unnatural activity, the emotions strained up to the highest tension, at such an important period, what chance has the body to attain a perfect growth or the various functions to be properly developed? Hence we see that generation after generation become smaller and smaller, until nature ceases to reproduce its own, and new blood has to be brought in to keep the race from dying out. Take a walk on the avenue of a Sunday afternoon and witness the large proportion of diminutive men and women which we shall meet. Then tell me if I have overdrawn the picture.

Now, whatever premature and excessive mental activity does in dwarfing the bodily growth and in enfeebling the functions in general, it effects, perhaps, even more the impairment of different organs and the curtailing of their special functions. There are very few well-formed bodies among our young women. The impression which an examination of the person gives is that they have been starved. And starved they literally are. The major part of the nourishment, which they could digest and assimilate, has gone to keep up the constant, excessive expenditure through the brain and nervous system, leaving an inadequate supply for the bodily growth and development.

There is always a limit to human endurance at every period of life. Even with adults, the man who thinks much must be content to work less. He cannot do both in equal measure at the same time. Or if he works severely with his muscles he must be satisfied with less rapidity in his mental operations. The body is equally starved, whether like the Australian bushman, from insufficiency of food, or like the Laplander, whose food is converted into fuel to keep up the animal heat; or like overworked children in some factory centers, whose bodies are dwarfed because all the food they eat is used to support their labor, and they have no vital remainder whereby growth may be effected; or, as in the case of the overwrought brains of our "civilized" children, which absorb an undue share of the vital forces, and thus the body is left to starve. Hence ill shapes and distortions. Hence want of symmetry as to the trunk, and disproportion in the extremities. Hence weak muscles and indigestion. Hence teeth imperfect in development, dentine soft, enamel defective and easily penetrated. Hence decay.

One who is not accustomed to examine the persons of large numbers of people can have no idea of the varying characters of bodily deficiencies and imperfections which he will meet without attracting the notice of the ordinary observer.

I have a patient now with one leg two inches longer than the other; and a difference of one inch in the length of the lower extremities is a relatively common occurrence. So of every portion of the body. It is seldom even tolerably perfect among the higher classes. And I have no doubt that the cause of these imperfections lies more in the diversion of the nutrition which should feed the bodily growth, from its proper direction, in consequence of emotional excitation, than any other cause which acts on the members of civilized communities. But, of course, there are exceptions to this rule as there are to every other; that is, there seem to be exceptions, but they are of such a character as to prove the rule.

We see persons with poor apologies for bodies, but with excellent teeth; while we also see persons with sound, strong bodies with defective teeth. When the nutritive supply is inadequate, accident determines which particular organ shall suffer most and which shall be comparatively well nourished. When any organ *may* suffer it is pretty certain that some one eventually *will* suffer. I repeat that those who seldom or never have occasion to examine the whole person can scarcely appreciate in what varied forms the results of the bodily starvation which I have pointed out in this paper may assume. I continually see persons with one-half of the trunk, perhaps, tolerably well formed, while the other half is defective in various particulars; not as the result of regular and recognized causes tending to produce a distortion of the spinal column, for instance, but as the result of imperfect growth and development alone.

When an acorn is dropped on the steep, rugged hillside, with scanty soil, the washing rains, the winds, the frosts, and the droughts, the tree it produces is blighted and dwarfed compared with its brother oak grown in the fertile valley. But no one can tell what particular branch of the scrubby oak will first decay. So with the starved and shrunken bodies; one cannot tell which organ will weaken and fail before the others. And it does not militate against the indictment which I bring against overworking the young brain by exciting intense emotions, to freely admit that multitudes escape in part or wholly many or all of the evils which others, with feebler powers of resistance, suffer from. For, after all, human nature is hard to kill, else the race would have been extinct long ages ago.

The surgeon's skill, the physician's art, the dentist's wonderful dexterity, may often largely compensate for defective organs and curtailed powers. Sanitary science, also, ventilates our dwellings, gives us baths and household comforts, and inventive genius largely abridges the drain on human muscular strength; so that we find two opposing sets of forces acting in opposite directions on the individuals composing society. One set of forces tends to weaken and abridge human life, while another set tends to strengthen and to lengthen it.

My object in this paper has been to call attention to some of the most important and, as I believe, less frequently appreciated of the influences which strongly tend to weaken and destroy life.

I am aware that it has been proposed to correct imperfect bodily development by various expedients, all more or less directly concerning the nutrition, either as medicaments, containing, in larger proportion or in more easily assimilable form than is to be found in ordinary food, some of the elements supposed to be in diminished amounts in the systems of delicate persons; or by a diet of substances containing the desired elements in greater abundance than exists in the ordinary food of the people. And there can be no doubt that something can be done in either direction which will have a good tendency and be calculated to ameliorate some of the worst results of the deteriorating effects of mental exhaustion. But, after all, such proposals must be considered as proceeding from very superficial examination into the causes of bodily imperfection in civilized communities.

The Chinese attain a good stature and have perfectly formed teeth on a diet of rice, and the Esquimaux have sound teeth on a diet of blubber. I do not pretend to say that either rice, blubber, or any other diet so imperfect as either must be will produce as good specimens of man, under the same or corresponding circumstances, as a food which contains the assimilable substances in better proportions. But my object is to show that there is something back of the food in the condition of the system which makes it possible for perfect men to be developed under such unfavorable conditions, or for so poor specimens to be so common in civilized communities, with all the advantages which the latter have over the barbarous in selecting food.

These indisputable facts cannot be reconciled except by supposing that the greatest factor of all in modifying bodily development lies in that which most distinguishes the civilized from the savage—the mind. It is here that we must look for most of the modifying influences on the bodily powers, and it is here where our remedies must be applied if we would see an average of bodily perfection in civilized society.

NEURALGIA.

DR. J. W. HICKMAN, writing to the *Med. and Surg. Reporter*, says:

Any treatment of neuralgia that does not take into prominent consideration the paroxysm, must be, to a greater or less extent, futile. Pain exhausts and depresses the vitality to such a fearful degree, that it must be checked at all hazards. Especially is this true of those cases in which the neuralgia depends upon a depraved and weakened condition of the general system. I would not detract one jot from the recognized importance of the general treatment, but would simply emphasize the importance of quelling the paroxysm of pain at its very invasion. If the neuralgia depend upon a diseased tooth, for instance, it would be unpardonable folly to content ourselves with a prompt subduing of the pain, while permitting the tooth to remain. The treatment of the attack proper, and the general treatment, are necessarily and thoroughly complementary to each other.

Generally speaking, there seems to be a tendency among practitioners to practically ignore the treatment of the paroxysm in their management of the various forms of neuralgia. Many seem never to have realized to themselves the real worth of prompt relief in such cases as the instance in question.

The very first thing to be done when called to a neuralgic patient who is being racked with agony, is to employ the most decisive means at our command.

To lay stress upon this point may seem to some like attempting to prove an axiom, but I know whereof I speak, when I say that the importance of this matter is greatly undervalued in actual practice.

Among the various remedial agents which have been used for this immediate treatment are morphia, atropia, inhalations of chloroform, aconite, Indian hemp, hyoscyamus, conium, bromide of potassium, etc. Some of this list, morphia and atropia more especially, are not merely efficient in rapidly allaying pain, but are positively curative in their action. To this fact we have the testimony of such high authorities as Bartholow, Hammond, and others.

Dr. Hunter has ascertained that atropia, hypodermically injected in sufficient quantity ($\frac{1}{80}$ to $\frac{1}{30}$ grain), has a permanently beneficial influence in tic-douloureux and sciatica, while Dr. Anstie has stated that the same remedy is particularly useful in peri-uterine and dysmenorrheal neuralgia. Again, morphia, the most widely used of the foregoing agents to several varieties of neuralgia, may be administered (hypodermically, of course) with confident prospects of lasting good. I have recently administered it in tic-douloureux, with excellent curative effect.

It would seem entirely superfluous to here offer even a word of caution as to the danger of the morphia habit. A little good whisky will, in some cases, frequently abort an attack, as I have seen abundantly verified.

We are well aware, however, that many of these agents have their drawbacks, but these are insignificant when weighed in the balance with the prostration and physical depression incident to an unallayed and violent neuralgic paroxysm. Atropia, though its effect in alleviating pain is more enduring than that of morphia, has attendant upon its action hallucinations, and occasionally delirium, and this, too, when given in legitimate doses. Attendant upon the action of morphia are frequently a persistent nausea and itching of the cutaneous surface (but we must remember that this nausea frequently occurs in the course of an attack of neuralgia, even when morphia is not exhibited).

Then again, following in its wake are some very unpleasant cerebral and other effects. These, as was first shown by Bartholow, may be prevented, or at least alleviated, by a full dose of bromide of potassium. As is well known, however, the ill effects of each of these drugs (morphia and atropia) are very largely counteracted when used in combination. We find now and then a case where morphia not only fails to afford any relief, but really intensifies the agony of the paroxysm. Tanner says in such instances he finds no remedy so valuable as a mixture of atropia and arsenic (gr. $\frac{1}{60}$ of the former to $\frac{1}{36}$ of the latter), used hypodermically.

Any, or, indeed, all, of the objections and ill effects incident to the administration of remedies to cut short the paroxysm, we repeat, do not form the slightest argument, in the face of facts, against the course of treatment above advocated.